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NEW YORK, FEBRUARY, 1892.

THE table of Locomotive Returns, which is given on another page, is a small beginning, which we hope will be in time increased to include a number of important roads. This can be done by the co-operation of superintendents of motive power, many of whom have already promised it. Comparative statements of this kind cannot fail to bring out some interesting points, and they may perhaps do the further service of impressing upon those in authority how desirable it is to have a uniform system of estimating and stating locomotive performance.

It may be added that we shall be much pleased to receive reports of locomotive service from any superintendent of motive power who may see this notice.

THE Engineering Society of the South has taken up the question of improving highway roads in earnest, and will try several plans to excite increased interest in it. Among others it proposes to have an exhibition of road machinery and tools, and of methods of making and maintaining roads, to be held in Nashville at an early day. It will also have a series of papers on Roads, to be prepared by members and read before the Society at intervals through the year. The object is an excellent one, and there is probably no way in which the Society can do a greater public service. It has certainly set an example worthy to be followed.

THE new railroad building of 1891, according to the statement prepared by the *Railway Age*, amounted to 4,168 miles, being less than in any year of the last ten, except 1884 and 1885, and only about one-third of that of 1887. It was still a fair addition to the railroad mileage of the country, and was distributed in such a way as to indicate that the new lines have generally been placed where they were needed. The building of parallel lines and extensions of competing lines into new territory have, in fact, almost ceased for the time.

As for two years past, the greatest additions have been in the South, but there was still considerable building in the Northwest. The Middle States also show a fair increase, 501 miles being reported in New York, Pennsylvania and New Jersey.

The length of the new lines built averages only about 17 miles, showing that the new mileage was largely of short branches and extensions.

THERE is a rapid transit commission in Boston, and it has recently submitted a preliminary report, proposing a belt or circular line in that city, connecting all the railroad stations and some other points. This line is to be partly an elevated and partly a subway road, and is to form the base from which elevated roads are to radiate out to Cambridge, Dorchester and other suburbs.

THE lake commerce has been so important of late years that it ought not to be a matter of surprise that some of our best ship-yards are now on the inland waters, though many persons do not appreciate the fact. The yards at Cleveland, Detroit, Bay City and other points have grown up to large dimensions within the past few years, and the work they do, both in ships and engines, will stand comparison with any of the yards on the seaboard. In fact, the Bay City yards have already built ships for the Atlantic, and others may follow before long.

THE adaptation of the "whaleback" type of ship to coast defense is proposed by its inventor, Captain McDougall. It includes the monitor principle of an almost entirely submerged hull combined with a strong form of protective deck, and guns could be mounted in a turret. The "whaleback" has, in fact, so many points of similarity to the monitor, that the suggestion of adapting it to war purposes is a natural one.

THE latest report of the Interstate Commerce Commission is an interesting one, and shows that the commissioners have not been idle during the year. The subjects which have been considered are Uniform Classification; Use of Shippers' Cars; Through Routes and Rates; Carriers' Liability, and Risk as Affecting Rates.

The Commission reports a marked improvement during the year in the disposition of carriers to comply with the law in many respects, though little progress has been made in establishing and publishing rates and charges. It is one of the difficulties in the way of the Commission that it can only enforce its orders by bringing suit in the courts, and cannot directly levy penalties or compel obedience.

Several amendments to the law are suggested, the chief of which are to the sections in relation to procedure for violations of the act. It is recommended that power be given to find indictments against the companies directly, instead of their officers. It is also asked that the law be amended so as to fix some time within which a uniform classification of freight must be adopted.

The Statistician's report to the Commission—a very valuable one—is referred to on another page.

THE New York Railroad Commission this year recommends legislation to prevent increase in the number of grade crossings, and to provide for the gradual abolition of those now in existence by separating the grades of railroads and highways wherever practicable. A law to regulate the building of new railroads and to prevent the unnecessary duplication of railroads and building of parallel lines is also recommended.

ENGLISH AND AMERICAN LOCOMOTIVES.

(*Continued from page* 6.)

IV.

In the preceding articles our argument has been that American locomotives burn more coal, and can therefore do more work in proportion to their size and weight than British engines do, and that by virtue of their greater capacity for doing work, they are more economical, counting all their expenses, than their Anglo-Saxon cotemporaries are. As further evidence that they do more work, we have collected from different locomotive superintendents data concerning the maximum of trains hauled on various roads in this country, which has been tabulated in Table IX.

DATA CONCERNING WEIGHT OF AMERICAN TRAINS.

The Engineer has complained that the parties who have taken part in this discussion on this side the Atlantic have failed to supply full information concerning the performance of American locomotives. In turn, we will complain of the total lack of data concerning the average weight of trains hauled on English roads. In Table III we gave the weight of average passenger and freight trains on a dozen different American lines. Can *The Engineer* give similar data concerning as many British roads? It must be observed that the figures we have given in that table are not haphazard guesses, but are summaries of accounts kept by the different companies for a whole year and published by them.

It is, of course, true that there are many trains on nearly all roads, the weight of which is limited, and there is then no object in pulling more than a given load. In such cases, the end to be aimed at is to haul such trains at as low an expense as possible. Here, too, it is difficult to make any comparisons which will have much value without knowing the weight and speed of such trains, the stops they must make, and the grades over which they must be hauled. The best data, probably, which is obtainable concerning the performance of American locomotives on trains of that kind, is contained in what are called the "coal allowance sheets," which are employed on the Pennsylvania Railroad lines.

A little explanation of the system in vogue on these roads may be needed to explain the significance of those allowance sheets. On the Philadelphia, Wilmington & Baltimore, and on the Pittsburgh, Fort Wayne & Chicago roads, for example, a certain allowance of coal—depending upon the character of the train, the nature of its run, schedule time, number of stops, etc.—is made for the engine and another allowance for each car per mile run. One half of the value of the saving of this allowance, which the engineer and fireman can make, is divided between them as a bonus. The allowances are revised each month, and are kept within such limits, so that skillful and careful men can make a bonus, while those who are indifferent, indolent or ignorant cannot. Through the favor of some of the officers on the lines referred to, we have received copies of the coal allowance sheets on those roads for the month of January of this year, from which Table X has been collated.

The coal allowed per train mile for the different classes of trains has been calculated and is given in the eleventh column, from which it will be seen that on the Philadelphia, Wilmington & Baltimore road the average for passenger trains is 55.61 lbs. and for freight 75.26 lbs. On the Pittsburgh, Fort Wayne & Chicago the corresponding figures are 49.8 and 130.9 lbs.

The coal allowed per ton per mile of the weight of the cars has also been computed, and the results are given in column 12. The average for passenger cars on the Philadelphia, Wilmington & Baltimore road is .694 lb. and for freight .253 lb. per ton per mile. On the Pittsburgh, Fort Wayne & Chicago it is 0.33 and 0.22 lb. The average consumption has also been calculated in a similar way for through and local or accommodation passenger trains, and for through and local freight trains.

It must be kept in mind that the figures in this table represent the ordinary every-day practice on the lines named, and are not reports of special experiments or tests, which always give better results than daily usage does. The coal allowance is also somewhat greater than the actual consumption, because many of the men run with less coal than the allowance, and thus, as has been explained, make a bonus on their month's work. The character of the trains hauled on the Philadelphia, Wilmington & Baltimore road is probably as near to that of average English trains as can be found in this country.

We are unable to compare these figures with English practice, because we have no similar reports of what is done on British roads. Can *The Engineer* give its readers some such data? The missing link in all reports of locomotive performance in the United Kingdom is the weight of their trains. The only way of getting such information seems to be by some process of inference, such as was employed in our article published in December. It will be remembered that from the "guess" of Mr. Ackworth, with reference to freight rates on British roads, the statistics of traffic receipts of goods trains per mile, and the hypothesis that the dead weight of "wagons" was twice the paying load hauled, the inference was that the average weight of English goods trains is 170 tons, not including the engine and tender. On the Philadelphia, Wilmington & Baltimore road the average of the weights given is nearly twice and on the Fort Wayne road it is more than three times as great. If we compare the daily performance on the Philadelphia, Wilmington & Baltimore road with the North British experiments, we find that on the former the average weight of trains was 336.8 tons, on the latter 243.4 tons; the consumption of coal per train mile was 75.26 lbs. in the first case and 64.56 in the second; the consumption of coal per ton of train per mile was .272 lbs. on the Scotch road and .253 on the Philadelphia, Wilmington & Baltimore. It may be repeated that in the one instance the figures represent the results of careful experiment, and in the other every-day practice.

Since the publication of these articles was commenced, reports have been published of some remarkable tests of fast express locomotives, of which we give the data in table XI. The first of these is from a brief report of the performance of a locomotive with a single pair of driving-wheels 7 ft. 7½ in. diameter, and with inside cylinders —which is the type of engine used on the Great Northern Railway of England. This report was published in *The Engineer* of November 6. In its issue of November 20 our cotemporary gave a report of a very remarkable performance of Mr. Webb's new compound engine "Greater Britain," which was illustrated in the last number of the Journal. A summary of this report is also given in our table. The third line contains the data of the per-

TABLE IX.—SHOWING THE MAXIMUM LOADS HAULED, WITH THE WEIGHT AND PERFORMANCE OF LOCOMOTIVES, ON DIFFERENT AMERICAN RAILROADS.

1. Name of Road.	2. Terminal Points.	3. Distance between Terminals.	4. Number of Loaded Freight Cars Hauled.	5. Number of Empty Freight Cars Hauled.	6. Number of Mail, Baggage, Express or Postal Cars Hauled.	7. Number of Coaches Hauled.	8. Number of Drawing-Room, Sleeping or Dining Cars Hauled.	9. Total Number of Cars Hauled.	10. Weight of Cars in Tons of 2,240 Lbs.	11. Maximum Grades on Run.	12. Schedule Time, including Stops.		13. Kind of Engine Employed.	14. Total Weight of Engine in Working Order.	15. Total Weight on Driving-Wheels.	16. Diameter of Driving-Wheels.	17. Size of Cylinders.	18. Coal Consumed per Mile.	19. Coal Consumed per Ton of Train Exclusive of Engine and Tender.	20. Proportion of Weight of Engine to Weight of Cars Hauled.	21. Miles per Hour.
PASSENGER TRAINS.																					
		Miles.							Tons of 2240 lbs	Ft. per m.	H.	M.		Lbs.	Lbs.	In.	In.	Lbs.	Lbs.		
Boston and Albany	Boston and Springfield	100			1	3	3	7	206	60	2	29	Am.	90,000	61,400	68	18 × 22			1 to 5.13	40.26
New York, New Haven and Hartford	Springfield and New York	137			1	5	2	8	219	45	3	29	"	100,000	62,700	68½	18⅛ × 24			1 " 4 9	39.30
" " " "	" " "	137			2	3	6	11	340	45	4	15	"	100,000	62,700	68½	18½ × 24			1 " 7.62	32.22
Fitchburg		143			3	4	3	10	284	60	5	..	"	94,660	60,660	68	18 × 24			1 " 6.73	28.56
Old Colony	Fall River and Boston	49			2	7	2	11	367.2	45½	1	20	"	98,000	63,210	69	18 × 24	63	.171	1 " 8.59	36.75
Missouri Pacific	St. Louis and Sedalia	189			2	5	5	12	352.7	52	6	55	10-wheel.	114,000	90,000	63	20 × 24	80	.227	1 " 6.03	27.30
Chicago, Burlington and Quincy	Galesburg and Chicago	162.5			2	3	3	8	261.1	37	4	2	Mogul.	110,000	91,500	68	19 × 24	56 2	.215	1 " 5.31	40.26
" " " "	Creston and Council Bluffs	105			3	3	4	10	294.6	69	3	10	"	110,000	91,500	62	19 × 24	76	.257	1 " 5.00	33.18
Delaware, Lackawanna and Western	Buffalo and Hoboken	409			4	3	3	10	348.7	75†	11	58	Am.	111,500	80,800	68	19 × 24			1 " 6.98	34.14
Baltimore and Ohio	Keyser, Md., and Grafton, W. Va.	78.7			3	2	1	6	187.3	116 (c)	3	45	10-wheel.	133,000	103,300	62	21 × 26	87	.464	1 " 3.15	20.94
Western New York and Pennsylvania	Oil City and Buffalo	137			2	7	1	10	247	90	5	..	Am.	87,000	58,000	62	17 × 24	80	.324	1 " 6.35	27.36
New York Central and Hudson River	New York and Albany	143			1	2	9	12	392		3	50	"	98,000	64,000	70	18 × 24			1 " 8.96	37.26
" " " "	" " "	143					8	8	298.5		3	25	"	120,000	80,000	70	19 × 24			1 " 5.57	41.82
Chicago and Northwestern	Chicago and Janesville	91			3	3	5	11	331	32			10-wheel.		94,500	64	18 × 24				33.00
" " "	" " Clinton	138			2	3	5	10	343	39.6			Am.		61,870	64	18 × 24				33.10
" " "	" " Turner	30			8	6	1	15	377	26.4			"		51,650	64	18 × 24				34.80
St. Louis and San Francisco	St. Louis and Newburg	119			3	4	2	9	288	70	4	30	10-wheel.	100,000	65,000	58	19 × 24	83⅛	.289	1 " 6.45	26.40
Chicago and Alton	Bloomington and Chicago	126⅛			3	4	4	11	402	52	4	55	Am.	85,000	56,000	63	17 × 24	67	.166	1 " 10.50	25.68
Canadian Pacific	Montreal and Toronto	344			2	3	5	10	335	52.8	10	55	10-wheel.	117,000	93,000	69	19 × 24	66	.197	1 " 6.41	30.66
Louisville and Nashville	Howell and Nashville	154			2	2	3	7	208	81‡‡	5	40	Am.	96,000	62,000	67	18 × 24			1 " 4.85	27.18
New York, Lake Erie and Western	Hornellsville and Susquehanna	139¾			2	3	3	8	272		4	10	"		80,400	68	19 × 24				33.54
" " " "	" " "	139¾							280.3		4	10	10-wheel.	118,700	101,000	68	20 × 24	76.8 (a)	.274	1 " 5.28	33.54
New York, Providence and Boston	Providence and New London	64			2	3	4	8	270.5		1	45	Am.	96,000	65,000	69	17 × 24	54	.299	1 " 6.31	36.54
Michigan Central	Jackson and Michigan City	153			2	3	6	11	379	45	5	50	10-wheel.	123,500	96,000	68	19 × 24			1 " 6.87	26.22
" "	Michigan City and Jackson	153				1	6	7	294.2	38	3	30	"	123,500	96,000	68	19 × 24			1 " 5.33	43.68
Atchison, Topeka and Santa Fé	Topeka and Nickerson	179			3	6	2	11	334.8	63	8	10	10-w. comp.	135,000	99,200	62	20 × 24, 29 × 24	72	.215	1 " 5.55	21.90
" " " "	La Junta and Denver	181			8	3	1	12	354.4	74	8	40	10-wheel.	121,000	87,000	56	18 × 24	88	.248	1 " 6.56	20.88
Wisconsin Central	Chicago and Waukesha	97.7			1	1	9	11	361.5	52.8	3	20	Am.	92,600	60,000	63	17 × 24	53	.146	1 " 8.74	29.28
Lake Shore and Michigan Southern	Buffalo and Erie	88			2	3	6	11	358	35	2	20	"	108,000	72,000	66	18 × 24	69.42	.194	1 " 7.48	37.68
Cleveland, Cinn., Chicago and St. Louis	Cincinnati and Chicago	110			3	2	5	10	357	42 (b)	3	15	10-wheel.	126,700	98,700	62	19 × 24	95.8	.268	1 " 6.31	33.84
Missouri, Kansas and Texas	Denison and Muscogee	158			3	3	3	9	290	53			Am.	82,000	52,000	62	17 × 24	50.08	.183	1 " 7.92	28.00
Baltimore and Ohio	Canton and Philadelphia	91.6			1	2	1	4	137 6	76	1	47	"	114,500	77,000	78	20 × 24	53	.385	1 " 2.71	51.30
Philadelphia and Reading	Philadelphia and Pottsville	93			2	4	2	8	225	28.5	2	52	" (e)	107,000	72,464	68½	21 × 22	67.18 (f)	.298	1 " 4 71	50.00
FREIGHT TRAINS.																					
Missouri Pacific	St. Louis and Chamois	100	45						1,125	52 & 36*			Consol.	114,000	103,000	50	20 × 24	117	.104	1 " 22.10	....
Delaware, Lackawanna and Western	Hoboken and Binghamton	207	28						1,125		11	33	Mogul.	98,000	85,220	62	19 × 24			1 " 25.71	17.88
Baltimore and Ohio§	Piedmont and Altamont	17	12	1 Caboose					333	116‡	2	4¼	Consol.	125,000	113,400	50	21 × 26	411	1.234	1 " 5.97	8.16
" " " §	" " "	17	14	1 "					452	116‡	1	54	"	155,150	137,600	50	22 × 28	382	.845	1 " 6.52	8.94
Western New York and Pennsylvania	Buffalo and Emporium	121	50						1,393	26	11	..	"	127,000	113,000	50¼	20 × 24	105	.075	1 " 24.57	11.00
New York Central and Hudson River	" " New York	440	56**						1,800	30	15	8	Mogul.	120,000	105,000	64	19 × 26			1 " 33.60	29.04
Chicago and Northwestern	Chicago and Clinton	135	40						718	36.9			10-wheel.		79,700	56¼	19 × 24				15.00
St. Louis and San Francisco	Choteau Ave. and Newburg	117	34						602	70	7	††	Consol.	117,000	101,600	51	20 × 24	100.	.166	1 " 11.52	16.68
Chicago and Alton	Bloomington and Brighton Park	121.5	35½						739	52	9	30	Am.	85,000	56,000	63	17 × 24	128¼	.173	1 " 19.53	12.78
Canadian Pacific	Montreal and Toronto	334.6	23						636	52.8	24	10	10-wheel.	108,000	88,000	62	18 × 24	90	.141	1 " 13.19	13.80
Chicago, Burlington and Quincy	Galesburg and Chicago	162.5	37						826	37	8	..	Mogul (d).	114,500	96,150	62	20 and 29 × 24	86.6	.105	1 " 16.15	20.28
" " " "	" " "	162.5	39						870	37	8	..	"	110,000	94,500	68	19 × 24	98.4	.113	1 " 17.71	20.28
" " " "	Creston and Council Bluffs	105	47½						781	69			Consol.	113,000	95,100	52	20 × 24	100	.128	1 " 15.48	....
Louisville and Nashville	Howell and Nashville	154	40						500	81‡‡	11	50	Consol.	118,600		51	20 × 24	96.22	.192		13.02
New York, Lake Erie and Western	Susquehanna and Hornellsville	139¾	65½						1,677		7	23	10-wheel.	138,100	111,750	62	21 × 26	158.1	.094	1 " 27.20	18.90
Michigan Central	Jackson and Michigan City	153	36	1 Caboose					1,000	45			Mogul.	102,000	88,000	57	19 × 24			1 " 21.96	....
Atchison, Topeka and Santa Fé	La Junta and Denver	181	38	16					1,000	74	13	35	10-wheel.	106,400	78,200	51	19 × 26	122	.122	1 " 21.05	13.32
Wisconsin Central	Waukesha and Stevens Point	151.4	34						803	52.8	11		Mogul.	107,050	89,900	57	19 × 26	61	.076	1 " 16.77	13.74
Lake Shore and Michigan Southern	Buffalo and Erie	88	50						1,473	35	6	25	"	118,000	100,000	54	19 × 24	89.64	.061	1 " 27.96	13.74
Cleveland, Chicago, Cinn. and St. Louis	Cincinnati and Chicago	110	35						1,060	42 (b)			10-wheel.	90,000		55	18 × 24	74	.070	1 " 26.38	....
Missouri, Kansas and Texas	Denison and Muscogee	158	27						755	53			Mogul.	100,000	86,000	53	19 × 24	103.55	.137	1 " 16.91	15.00
Old Colony	Mansfield and South Framingham	21	32½						715	50	1	20	"	108,500	93,000	54	19 × 24	87	.122	1 " 14.76	15.70
Philadelphia and Reading	Schuylkill Haven and Belmont	85.6	100						1,547		9	43	10-wheel (e).	121,000	94,000	60⅝	20 × 24	151.7	.098	1 " 28.64	....
" " "	Palo Alto and Reading	36.5	55						1,899				Consol (e).	116,800	101,470	50½	20 × 24			1 " 36.42	....
" " "	Reading and Philadelphia	58	50						1,719				"	116,800	101,470	50½	20 × 24			1 " 32.96	....
" " "	Schuylkill Haven and Phila. (g)	89	90						3,102				"	153,000	138,530	50½	22 × 28			1 " 45.42	....

* Pushing engine is used on the 52-ft. grade, but not on 36. † Engine has helper on this grade. ‡ 10° curves on grade; no reduction of grade on curves. § Experimental trips; no helping engine was used. ** These cars weigh 28,000 lbs., and their average load is 44,000=total, 72,000 lbs. †† Grade 26,300 ft. ‡‡ The maximum grade on this run is 217 ft. per mile for 1.8 miles and curves of 573.7 ft. radius, but the trains are divided here, and helping engines are used. (a) Poor quality of anthracite coal. (b) One grade of 70 ft., on which helper is used. (c) This grade is 17 miles long. (d) Compound. (e) Wootton engine. (f) Anthracite. (g) Experimental train.

TABLE X. SHOWING THE ALLOWANCES OF COAL PER ENGINE AND PER CAR MILE ON THE PHILADELPHIA, WILMINGTON AND BALTIMORE, AND THE PITTSBURGH, FORT WAYNE AND CHICAGO RAILROADS.

PHILADELPHIA, WILMINGTON AND BALTIMORE RAILROAD.

TERMINAL POINTS.	Distance between Terminal Points.	Number of Stops.	Maximum Grades.	Schedule Time, Including Stops.	Speed in Miles per Hour, Including Stops.	Average Number of Loaded Cars.	Average Weight of Train Exclusive of Engine and Tender.	Allowance of Coal for Engine per Mile.	Allowance of Coal for Each Car per Mile.	Coal Allowed per Train Mile.	Coal Allowed per Ton of Cars per Mile, Including that Allowed for Engine.
	Miles.	No.	Ft. per Mile.	Minutes.	Miles per Hour.	No.	Tons of 2,240 lbs.	Lbs.	Lbs.	Lbs.	Lbs.
LOCAL PASSENGER TRAINS.											
Philadelphia and Baltimore	95.8	29.5	37.	179.2	31.9	3.76	93.3	18.	8.0	48.08	.723
" " Newark	26.2	16.8	30.	61.9	25.4	3.85	95.5	22.	10.0	57.36	.808
" " Lamokin	19.4	12.7	30.	45.1	25.8	4.18	103.5	22.	10 2	60.50	.584
Baltimore " Washington	42.6	14.0	53.	84.0	30.4	3.67	91.1	20.	8.8	52.29	.574
" " Catonsville	13.2	15.5	132.	32.2	25.0	2.46	62.0	25.	15.0	51.90	.837
Washington " Quantico	34.5	10.0	53.	82.5	25.2	4.79	118.1	20.	8.2	59.27	.502
" " Alexandria	6.7	5.0	53.	20.0	20.1	3.40	84.6	25.	10.2	59.68	.705
Averages							92.6			55.58	.676
NEWSPAPER TRAIN.											
Washington and Baltimore	42.2	13.0	53.	75.0	33.7	1.84	46.6	25.	13.5	49.84	1.078
THROUGH PASSENGER TRAIN.											
Philadelphia and Washington	137.6	11.5	53.	223.9	36.9	5.70	140.1			61.56	.439
Average of all passenger trains										55.61	.694
THROUGH FREIGHT TRAINS.											
Philadelphia and Baltimore	95.8		37.			20.25	506.2	14.	3.0	74.75	.147
Baltimore " Washington	42.6		53.			15.09	377.2	16.	3.8	73.34	.194
Quantico " "	34.5		53.			15.15	378.7	16.	4.0	76.60	.202
Averages							420.7			74.8 9	.181
FAST FREIGHT TRAIN.											
Philadelphia and Wilmington	26.8		30.			18.17	454.2	16.	3.8	95.04	.209
LOCAL FREIGHT TRAINS.											
Philadelphia and Wilmington	26.8		30.			6.82	170.5	18.	6.4	61.64	.361
Wilmington " Perryville	32.9		37.			8.38	209 5	18.	7.8	83.36	.400
Baltimore " "	36.1		21.			8.46	211.5	18.	6.4	72.14	.341
Philadelphia " "	59.7		37.			16.06	401.5	16.	3.6	73.81	.183
Quantico " Washington	34.5		51.			11.49	287.2	18.	4.8	55.15	.193
Baltimore " "	42.6		53.			6.39	160.2	16.	7.8	65.84	.411
Averages							220.1			68.66	.315
COLUMBIA FREIGHT TRAIN.											
Wilmington and Perryville	32.9		37.			20.29	507.2	16.	3.6	89.04	.175
DISC. FREIGHT TRAIN.											
Quantico and Washington	34.5		53.			15.10	377.5	16.	4.4	82.44	.218
Average of all freight trains							336.8			75.26	.253

PITTSBURGH, FORT WAYNE AND CHICAGO LINE.

TERMINAL POINTS.	Distance between Terminal Points.	Number of Stops.	Maximum Grades.	Schedule Time, Including Stops.	Speed in Miles per Hour, Including Stops.	Average Number of Loaded Cars.	Average Weight of Train Exclusive of Engine and Tender.	Allowance of Coal for Engine per Mile.	Allowance of Coal for Each Car per Mile.	Coal Allowed per Train Mile.	Coal Allowed per Ton of Cars per Mile, Including that Allowed for Engine.
THROUGH PASSENGER TRAINS.											
EASTERN DIVISION.											
Pittsburgh and Crestline	188.8	19	59.14	430	26.33	8	218.8	30.0	5.0	70 0	0.32
" " "	188.8	7	58.61	345	32.83	5	134.9	30.0	8.0	70.0	0.52
" " "	188 8	26	59.14	465	24.36	8	218.8	30.0	5.5	74.0	0.34
" " "	188.8	32	58.61	520	21.98	7	183.0	30 0	4.5	61.5	0 34
" " "	188.8	11	58.61	405	27.97	9	254.5	30.0	5.5	79.5	0.32
" " "	188.8	10	59.14	385	29.42	10	281.3	30.0	6.0	90.0	0.32
" " "	188.8	39	58.61	450	25.17	5	134.9	30.0	6.5	62.5	0 46
" " "	188.8	29	58.61	445	25.46	7	183.0	30 0	5.5	68.5	0.37
" " "	188.8	5	59.14	350	32.36	6	159.0	30.0	6 0	66.0	0.42
" and Alliance.	83.2	5	58.61	165	30.25	10	281.3	30.0	4.5	75.0	0.27
" " "	83.2	30	59.14	215	43.22	5	134.9	30.0	7.0	65.0	0.48
Average							198.6			71.1	0.36
WESTERN DIVISION, SUBDIVISION C.											
Crestline and Fort Wayne	131.2	25	33.79	280	28.11	7	183.0	25.0	5.0	60.0	0.33
" " " "	131.2	8	31.68	190	41.43	5	134.9	25.0	8.0	65.0	0.48
" " " "	131.2	16	33.79	280	28 11	8	218.8	25.0	2.8	47.4	0.22
" " " "	131.2	18	31.68	285	27 62	10	281.3	25 0	5.0	75.0	0.27
" " " "	131.2	18	31.68	285	27.62	5	134.9	25.0	1.5	32.5	0.24
" " " "	131.2	9	33.79	185	42.55	5	134.9	25.0	7.0	60.0	0.44
" " " "	131.2	8	33.79	193	40.79	5	134.9	25.0	5.0	50.0	0.37
" " " "	131.2	13	31.68	230	39.36	9	254.5	25.0	5.5	74.5	0 29
Average							184.7			58.1	0.32
WESTERN DIVISION, SUBDIVISION D.											
Fort Wayne and Chicago	148.3	31	35.33	305	29.17	7	183 0	25.0	3.5	49.5	0.27
" " "	148.3	19	35.33	315	28.25	8	218.8	25.0	4.3	59.4	0.27
" " "	148.3	23	33.79	330	26.96	9	254.5	25.0	2.5	47.5	0.19
" " "	148.3	12	35.33	240	37.08	6	159.0	25.0	7.2	68.2	0.43
" " "	148.3	12	35.33	260	34.22	5	134.9	25.0	4.5	47.5	0.35
" " "	148.3	17	33.79	270	32.96	10	281.3	25.0	4.5	70.0	0.25
" " "	148.3	15	35.33	265	33.58	7	183.0	25.0	5.4	67.8	0.34
" " "	148.3	30	33.79	305	29.17	7	183.0	25.0	5.0	60.0	0.33
" " "	148.3	13	33.79	240	37.08	6	159.0	25.0	7.0	67.0	0.42
Average							195.2			59.1	0.30

Terminal Points.	Distance between Terminal Points.	Number of Stops.	Maximum Grades.	Schedule Time, Including Stops.	Speed in Miles per Hour, Including Stops.	Average Number of Loaded Cars.	Average Weight of Train Exclusive of Engine and Tender.	Allowance of Coal for Engine per Mile.	Allowance of Coal for Each Car per Mile.	Coal Allowed per Train Mile.	Coal Allowed per Ton of Cars per Mile, Including that Allowed for Engine.
	Miles.	No.	Ft. per mile.	Minutes.	Miles per hour.	No.	Tons of 2,240 lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Cleveland and Pittsburgh Division.											
Cleveland and Pittsburgh	149.3	45	52.80	380	23.57	6	159.0	20.0	7.2	63.2	0.40
" " Ravenna and Return	76.0	30	40.00	115	19.83	4	110.7	20.0	10.0	60.0	0.54
" " Alliance " "	113.0	18	40.00	145	23.39	3	86.6	20.0	9.0	47.0	0.54
" " Hudson " "	52.4	8	40.00	65	24.00	4	110.7	20.0	9.5	58.0	0.52
" " Pittsburgh	149.3	43	52.80	390	22.97	5	134.9	20.0	7.3	56.5	0.42
Average	......	......	......	......	......	......	120 4	......	......	56.9	0.47
Toledo Division.											
Mansfield and Toledo	85.6	32	48.00	180	28.53	5	134.9	20.0	7.5	57.5	0.43
" " "	85.6	30	48.00	180	28.53	3	86.6	20.0	5.2	35.6	0.41
" " "	85.6	32	48.00	195	26.34	3	86.6	20.0	5.5	36.5	0.42
" " "	85.6	32	48.00	190	27.03	3	86.6	20.0	6.8	40.4	0.47
" " "	85.6	32	48.00	190	27.03	4	110.7	20.0	5.5	42.0	0.38
Average	......	......	......	......	......	......	101.1	......	......	42.4	0.42
ACCOMMODATION TRAINS.											
Eastern Division.											
Trains 41, 42, 43, 44	44.2	40	59.14	120	22.10	5	123.2	30.0	11.0	85.0	0.69
" 111, 112, 113, 118	13.7	19	43.30	45	18.27	4	99.1	30.0	11.0	74.0	0.75
" 54, 55	29.9	23	52.80	75	23.92	5	123.2	30.0	11.0	85.0	0.69
" 52, 51, 56, 57	29.9	23	52.80	75	23.92	5	123.2	30.0	9.0	75.0	0.61
" 107, 109, 114, 115, 116, 122, 123, 132	13.7	21	43.30	45	18.27	4	99.1	30.0	8.5	64.0	0.65
Average	......	......	......	......	......	......	113.6	......	......	76.6	0.68
Western Division.											
Local train 35	131.2	25	33.79	270	29.16	3	75.0	25.0	1.5	29.5	0.39
" " 36	131.2	25	31.68	320	24.60	3	75.0	25.0	2.0	31.0	0.41
" " 38	148.3	33	33.79	310	28.70	3	75.0	25.0	5.0	40.0	0.53
" " 40	148.3	21	33.79	325	27.38	5	123.2	25.0	1.5	32.5	0.26
" " 47, 48	64.1	15	35.33	75	28.44	3	75.0	25.0	3.0	34.0	0.45
Chicago local trains, daily average	85.6	23	....	285	18.55	3	75.0	25.0	17.0	76.0	1.01
Average	......	......	......	......	......	......	83.0	......	......	40.5	0.49
Cleveland and Pittsburgh Division.											
River Division Accommodations 39, 40	189.2	94	31.68	255	22.26	3	75.0	20.0	10.0	50.0	0.67
" " " 58, 59, 338	139.2	113	31.68	130	31.42	3	75.0	20.0	13.0	59.0	0.79
Average	......	......	......	......	......	......	75.0	......	......	54.5	0.73
Average of all passenger trains	......	......	......	......	......	......	151.8	......	......	49.8	0.33
THROUGH FREIGHTS.											
Eastern Division.											
Allegheny and Crestline	186.8	6	59.14	740	15.14	24	600.0	30.0	3.0	102.0	0.17
Conway and Crestline	166.1	6	59.14	660	15.10	24	600.0	30.0	3.5	114.0	0.19
Allegheny and Alliance	82.2	0	59.14	320	15.41	24	600.0	30.0	4.0	126.0	0.21
Allegheny and Conway	20.7	0	26.40	80	15.43	35	875 0	30.0	3.0	135.0	0.15
Alliance and Crestline	105.2	5	51.22	405	....	24	600.0	30.0	3.2	106.8	0.18
Average	......	......	......	......	......	......	655.0	......	......	116.8	0.18
Western Division.											
Crestline and Fort Wayne	131.2	10	33.79	727	10.83	40	1000.0	30.0	2.0	110.0	0.11
Cleveland and Pittsburgh Division.											
River Division trains 72, 73, 74, 75	185 6	50	31.68	955	11 66	40	1000 0	25.0	3.5	165.0	0.17
" " " 78, 79	43.8	32	31.68	645	4.07	40	1000.0	25.0	6.0	265.0	0.27
Average	......	......	......	......	......	......	1000.0	......	......	215.0	0.21
LOCAL FREIGHTS.											
Eastern Division.											
Allegheny and Alliance	81.2	....	59.14	320	15.23	18	450.0	30.0	7.0	156.0	0.35
" " "	81.2	....	59.14	320	15.23	10	250.0	30.0	6.0	90.0	0.36
Alliance and Crestline	106.0	....	51.22	405	15.70	10	250.0	30.0	5.0	80.0	0.32
Average	......	......	......	......	......	......	316.7	......	......	108.7	0.34
Western Division.											
Subdivision C, local train 86	71.8	16	28.51	565	7.62	25	625.0	....	7.0	....	....
" " " " 87	71.8	17	33.79	500	8.62	25	625.0	....	3.0	....	....
" " " " 89	59.4	13	28.30	515	6.92	25	625.0	....	5.5	....	....
Subdivision D, local trains 90, 91	64 1	17	35.33	490	7.85	25	625.0	....	4.0	....	....
" " milk train	43.9	9	27.98	130	20.23	2	50.0	25.0	10.5	46.0	0.92
Average	......	......	......	......	......	......	510.0	......	......	....	....
Cleveland and Pittsburgh Division.											
Local freight	99.0	29	...	600	9.90	8	200.0	25.0	6.0	73.0	0.37
Hill train	73.1	12	52.80	660	6.65	19	475.0	25.0	12.0	253.0	0.48
River Division local freight	72 0	34	31.68	600	7.20	20	500.0	25.0	6.0	145.0	0.29
Average	......	......	......	......	......	......	391.7	......	......	157.0	0.40
Toledo Division.											
Toledo and Mansfield, local	85.6	32	43.00	565	9.09	25	625.0	20.0	4.6	135.0	0.22
" " " through	85.6	32	43.00	620	8.28	21	525.0	20.0	5.8	141.8	0.27
" " " "	85.6	12	43.00	405	12.68	25	625.0	20.0	2.8	90.0	0.14
" " " "	85.6	12	43.00	455	11.29	21	525.0	20.0	4.7	110.3	0.21
" " " extra	85.6	12	43.00	360	14.27	25	625.0	20.0	2.8	90.0	0.14
Average	......	......	......	......	......	......	585.0	......	......	113.4	0.19
Average of all freight trains	......	......	......	......	......	......	596.1	......	......	130.9	0.22

Table XI. Showing the Performance of Fast Express Locomotives on Different Roads.

Road.	Designer of Engine.	Date of Test.	Weight of Engine.	4 Weight of Train Exclusive of Engine and Tender.	5 Proportion of Weight of Engine alone to Train of Cars alone.	6 Distance Run.	7 Speed in Miles per Hour.	8 Coal Consumption per Train Mile.	9 Coal Consumption per Ton of Train—not including Engine and Tender—per Train Mile.
			Tons of 2,240 lbs.	Tons of 2,240 lbs.		Miles.		Lbs.	Lbs.
1 Great Northern Railway	Patrick Sterling.	....	40.13	177.6	1 to 4.42	....	50+	30.6	.170
2 London & Northwestern..................	F. W. Webb....	Nov. 4, 1891	52.	305.5	1 " 5.76	158.	42.8	41.1	.134
3 Chemin de Fer du Nord.	M. du Bousquet.	Oct. 16, 1891	43.	139.	1 " 3.23	184.6	53.3	......	....
4 New York Central & Hudson River.....	Wm. Buchanan.	Apr. 5, 1890	42.2	341.	1 " 8.08	143.	45.64	60.95	.178
5 " " " " "	"	Apr. 29, 1890	42.2	261.5	1 " 6.19	143.	42.9	45.03	.172
6 " " " " "	"	Apr. 29, 1890	42.2	261.5	1 " 6.19	143.	41.85	46.0	.176
7 " " " " "	"	May 10, 1890	42.2	261.5	1 " 6.19	143.	41.85	30.63	.117

formance of a French engine, and in the fourth to the seventh the figures are given of the working of an engine on the Hudson River road.

The report of the working of Mr. Webb's new engine is certainly very remarkable. The amount of water evaporated per pound of coal is said to have been 10.96 lbs. We have no reason for doubting the correctness of the report, of which Mr. Webb's reputation is sufficient guarantee. If the remarkable results obtained in this experimental trip are realized in practice, the plan of boiler which Mr. Webb has introduced will probably be generally adopted. Before doing so, it would be well, however, to have fuller information about the manner in which the remarkable results were obtained, and wait for the reports of every-day working.

In speaking of the performance of the North British engine, *The Engineer* says, "It consumed 30.6 lbs. of *best South Yorkshire coal* per mile run." Now, what is meant by the *best* coal? Perhaps the following extract from a letter received from an Englishman, now employed on one of our leading American roads, may throw some light on the question. He says:

"As regards the quality of coal they use in England, I can say, from my own knowledge, it is the best that can be obtained. In the locality where I was stationed we had principally Ebbwvale and Tredegar coal, the best Welsh coal in the market; and it was stated in the contract it was to be *hand picked;* that was understood to be clean coal, *all lumps*, no dirt whatever. This, I assure you, is very different from the quality we use in America."

Now in comparing the performance of one engine with another, it is of importance to know what kind of coal was used. We admit that even with the best coal the results of the experiments with Mr. Webb's engine are very remarkable; but in order to make a comparison of the ordinary performance of an American engine with that of the foreign engines reported in our table, we have selected several runs on the Hudson River road which were made under Mr. Buchanan's supervision in the ordinary traffic of the road. The coal used was not of the best quality, and was used because it was cheap. The Hudson River road, it should be added, is nearly level, and probably not so hard a line to work as the three foreign lines are, but we have no record of their grades and curves.

From the table it will be seen that the Great Northern engine pulled 4.42 times its own weight, the French engine 3.23 times, Mr. Webb's 5.76 times, and in one run the Hudson River engine's train was 8.08 times as heavy as itself. With this heavy train the coal consumption was .178 lb. per ton per mile, whereas Mr. Webb's burned only .134 lb.; but with a train 6.19 times as heavy as itself, Mr. Buchanan's engine burned only .117 lb. of coal per ton per mile.

Now it is freely admitted that this comparison is not conclusive evidence of the merits of the engines, because the alignment of the roads, the quality of the fuel and other conditions were not the same; but the data are given to indicate that it is by no means a foregone conclusion, as *The Engineer* seems to assume, that under like conditions American express engines are not equally economical in fuel consumption as their foreign cotemporaries are. It is obviously unfair to compare an English compound with American simple locomotives; but the reports of the working of compound locomotives in this country have not yet emerged from that turbid condition which all subjects seem to get into when they are first stirred up. *The Engineer*, we trust, will give its readers the latest and fullest information regarding the working of compound locomotives in its own country, and the Railroad and Engineering Journal will perform a similar service for its readers by reporting what is done here by the same class of engines. If our knowledge is thus increased, this discussion will not have been futile. Up to the present point it may, we think, be fairly summarized by saying that it has been shown:

1. That the average annual mileage of locomotives on the railroads of the United Kingdom is 24,610; in this country it is 35,650.

2. The average weight of passenger trains, not including engines and tenders, as shown by the reports of 12 leading roads in this country, is 130.3 tons; that of freight trains is 601.5 tons. The average weight of trains in Eng-

land, Scotland and Ireland is not known. There is good reason for thinking, though, that the weight of our trains is much greater than the average on British lines. If this is true, it will follow that American locomotives not only run further, but they haul heavier loads than English engines do.

3. The average cost of repairs of the latter is 5.30 cents per mile run, while that of American locomotives is only 4.25 cents. Therefore they run further, pull more, and cost less than their congeners on the "tight little island."

4. The maximum rate of combustion per square foot of grate per hour, in our locomotives, is considerably over 100 lbs., and it has been shown that it is at times as much as 193.7 lbs., and is reported as being over 200 lbs. *The Engineer* has admitted that "*we have nothing in England to equal this. About 75 lbs. per square foot of grate per hour may be regarded as a maximum consumption with our fastest and heaviest expresses.*" Now either *The Engineer* is mistaken in this admission, or else the greater capacity which American locomotives have of burning coal enables them to generate more steam and thus pull heavier loads. It is believed that *The Engineer* was wrong when it made the above admission, but we also believe that if it should change the above estimate so as to correspond with actual practice in its own country, it will still be found that our locomotives have a greater capacity for burning coal, generating steam, and doing work than English engines have.

5. While statistics show that the average amount of fuel burned per train mile is less on English than on American roads, the quantity of fuel, if computed per ton of train hauled per mile, is less here than it is on English roads; and if all the expenses dependent upon the efficiency of locomotives is taken into account it is found that our expenses per unit of weight of train hauled is very much less than theirs. A comparison of the experiments made on the North British and the New York Central roads, in our Table VII, shows that these expenses on the former road were *four times* what they were on the latter.

6. The fact that the average earnings for carrying freight is only a little over a half a cent per ton per mile on our great railroads, whereas a good authority estimates the average rate on British roads at 1¼*d.* = 2½ cents, is indicative that the cost of locomotive service is much less here than it is in the United Kingdom.

7. Unless these conclusions are refuted or shown to be fallacious, it will follow that railroad authorities in Canada, and other British colonies, and foreign countries have and will in future show wisdom, and not ignorance or prejudice, as *The Engineer* has intimated, in equipping their roads with American instead of English motive power.

We will add that we have been promised by a locomotive superintendent of one of the principal English railways, full detail drawings of a representative express locomotive, designed and built by him for his line. If these drawings are received, we intend to have them engraved, and give corresponding illustrations of an American locomotive corresponding thereto, with critical descriptions and comparisons. We are now inclined to think that such a series of articles will show our English cotemporaries many features in our engines which they might adopt with advantage, and doubtless there will be much in the practice of our cousins that will be profitable for us to imitate. Should such mutual enlightenment be the result of this series of articles, their purpose will be fully accomplished.

LOCOMOTIVE STEPS.

In the last annual report on the Statistics of Railroads made to the Interstate Commerce Commission by its Statistician, it is shown that 561 railroad employés were killed and 2,363 were injured during the year 1891 by "falling from trains and engines." It is not shown, in this report, how many of these persons were killed or injured by falling from cars and how many by falling from engines. It is not possible to tell, therefore, the relative danger to which those who are employed on the cars and those whose duties confine them to the engine and tender are exposed. But any one who will examine or, better still, will use the steps and hand-rails which are provided for getting on and off of locomotives must, it is thought, be convinced that they expose those who use them to unnecessary risk. A very common form of locomotive steps which is used in this country is shown in fig. 1. These consist of round or oval plates attached by set screws to a vertical rod or bar which is supported by the tail-brace of the engine frame. Usually they are made without any guard around their edges to

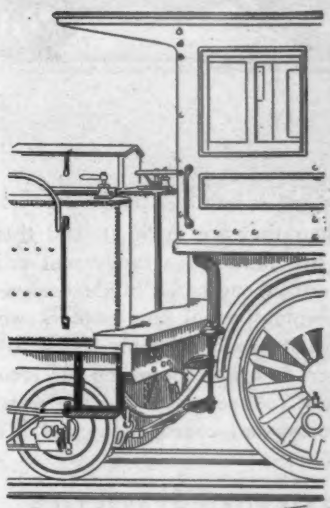


Fig. 1.

prevent a person's foot from sliding off of the step. It is difficult at best to get a firm foothold on a round plate, from the edge of which a person's foot is liable to slip. The danger is increased at night, when it is impossible to see the step distinctly, or in winter, when it is coated with ice. Such steps are usually entirely too small, and there is nothing back of them to prevent a person's foot from getting in behind them in case he misses his foothold. The danger of this is often increased by the height of the step, which is so great as to be difficult to reach when the earth or the ballast slopes downward from the rails where the engine happens to be. Under such circumstances too it is often difficult or impossible to reach the hand-rails or hand-holds on the cab and on the tank.

In the articles which have been published in this and preceding numbers of this Journal we have shown at considerable length wherein American locomotives were superior to those made and used in Great Britain. There is no chance, therefore, of accusing us of prejudice in favor of that which is foreign when we call attention to the greater safety and security to employés which is provided by the steps used on British locomotives compared with those ordinarily used here. Fig. 2 shows a form of locomotive and tender step which is much used on the other side. It will be seen from this engraving that these steps are of liberal size, and are attached to a vertical plate or

riser, so that the foot of a person using them is not liable to slip behind the step in case of missing a foothold. The edges of the steps, too, are turned up with a sort of flange which acts as a guard to prevent the foot from slipping off of the step. The lower step and the hand-rails are

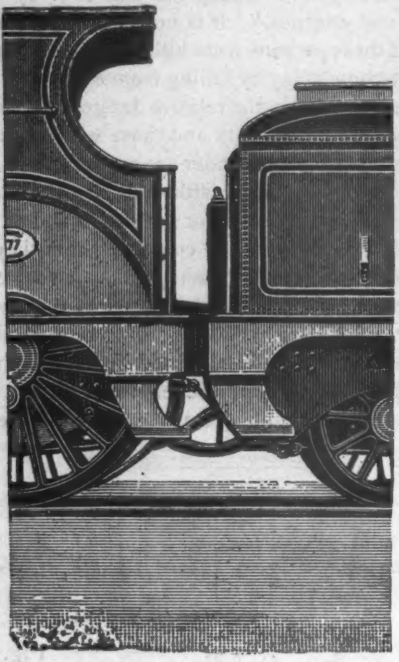


Fig. 2.

lower down than they are in fig. 1, and therefore more convenient to use than the arrangement ordinarily employed on American engines. In the design of these attachments to locomotives, if our builders would imitate English practice it would probably lessen to some extent the many dangers to which those who run locomotives are now exposed, and reduce somewhat the number of accidents to this worthy and courageous class of railroad employés.

RAILROAD STATISTICS.

Third Annual Report on the Statistics of Railroads in the United States. By Henry C. Adams, Statistician to the Interstate Commerce Commission.

From time to time reference has been made in these columns to the advantages to be gained by securing uniform and reliable statistics of the railroads of the United States, and also to the steps which had been taken by the Interstate Commerce Commission to secure such statistics. What has been gained in that direction is shown by the advance copy of the report of the Statistician of the Commission for the year ending June 30, 1890, which has just been issued. That over a year has passed since the close of the term covered by the report is due to the many delays necessary in collecting the reports and in properly analyzing and collating the great body of figures assembled.

It is utterly impossible to give a proper summary of the report within the limits of a single article, and the most that can be done is to call attention to its leading features, some of which we hope to be able to refer to at greater length hereafter

A prominent feature of the report is the division of the railroads into ten groups, the statistics of each group being presented separately. The great difference in the density of population, the amount of traffic and the conditions of operation make this method of presentation much more valuable to the student of railroad economics than the plan heretofore adopted of massing the figures for the whole country. How the division has been made and what the groups are is shown at a glance by the accompanying map, which is taken from the report itself. Of course, in any division of this kind there must be some overlapping—that is, there must be some roads which are partly in one group and partly in another; but the plan adopted is an excellent one, and it would hardly be possible to give a closer classification.

First, however, it may be well to give a few general figures showing the great importance of the railroad interest in this country.

Railroad mileage in the United States on June 30, 1890, was 163 597 miles. The increase in mileage brought into operation during the year was 5,838 miles. Michigan shows the largest increase during the year, being 459 miles, and Georgia comes next, with an increase of 438 miles. Group V, made up of the States of Kentucky, Tennessee, Mississippi, Alabama, Georgia and Florida, shows an increased mileage of 1,370 miles during the year. The total length of track for the United States, including all tracks, sidings and spurs, is 208,613 miles.

The number of railroad corporations on June 30, 1890, was 1,797. Of these 87 are classed as private roads, with a total operated mileage of 812 miles. Nine hundred and twenty-seven of these corporations are operating companies, and 735 are subsidiary companies—that is to say, the mileage which they own is leased to other companies for the purpose of operation. Twenty-two companies, representing a mileage of 1,646 miles, were reorganized during the year, and 34 companies, representing a mileage of 1,906 miles, merged their corporate existence into other corporations. Fifty companies, representing a mileage of 6,196 miles, were consolidated with other companies. Thus 8,102 miles of line during the year disappeared as independent companies.

Forty railroad corporations operate 77,873 miles of line, or 47.51 per cent. of total mileage. The average length of line for these 40 roads is nearly 2,000 miles. There are 75 companies in the United States whose gross income is $846,888,000, out of a total gross income of all railroads in the country of $1,051,877,632—that is to say, 75 railroad corporations receive 80 per cent. of the total amount paid by the people of the United States for railroad service.

The total number of locomotives in the United States is 29,928, of which 8,384 are passenger locomotives and 16,140 are freight locomotives. This shows 10 freight locomotives and 5 passenger locomotives for each 100 miles of operated line. The number of cars used on the railroads of the United States is 1,164,188, of which 26,511 are in the passenger service. The number of cars per 100 miles of line is 744. The number of tons of freight carried one mile per freight engine is 4,721,627, and the number of passengers carried one mile per passenger engine is 1,413,142. Figures of this sort measure the economy of transportation by rail. The larger portion of equipment is found on railroads in the Eastern and Middle States. Thus, in the New England States, Group I, there are 28 locomotives per 100 miles of line; in the Middle States, Group II, 46 locomotives per 100 miles of line; while in the States west of the Mississippi the number does not exceed 15 locomotives per 100 miles of line. The number of locomotives fitted with train brake is 20,162, and the number fitted with automatic coupler, 955. The number of cars fitted with train brake is 128,241, and the number of cars fitted with automatic coupler is 114,364. When compared with the total number of locomotives and cars, it appears that much remains to be done in the matter of train brakes and automatic couplers.

The total number of men employed on the railroads of the United States is 749,301, being an increase of 44,558 over the number employed in 1889. The average number of men employed per 100 miles of line on all roads is 479.

The 156,404 miles of line, which is made the basis of statistics in this report, is represented by railroad capital to the amount of $9,437,353,372, which is equivalent to $60,340 per mile of

COMPARATIVE SUMMARY OF ITEMS, BY GROUPS.

TERRITORY COVERED.	Gross earnings per mile of line.	Operating expenses per mile of line.	Locomotives per 100 miles of line.	Men employed per 100 miles of line.	Passenger mileage per mile of line.	Freight mileage per mile of line.	Revenue per passenger per mile.	Revenue per ton per mile.	Per cent. of passenger earnings to total earnings.	Per cent. of freight earnings to total earnings.	Value of property per mile computed at 5 per cent. on earning capacity.
							Cents.	Cents.			
Group I	$10,444	$7,975	28	716	233,530	383,505	1.912	1.373	47.50	51.36	$57,867
Group II	15,829	10,275	46	1,167	183,121	1,348,107	2.029	.828	27.33	70.28	107,741
Group III	7,785	5,322	24	576	85,572	793,763	2.199	.695	28.72	69.33	45,941
Group IV	4,279	2,886	13	379	43,039	330,981	2.481	.844	30.94	66.93	25,177
Group V	4,945	3,278	14	386	46,869	304,936	2.465	1.061	29.16	67.77	30,206
Group VI	5,195	3,324	15	359	50,059	376,403	2.226	.961	26.87	70.97	36,406
Group VII	5,128	3,007	12	328	46,148	269,866	2.452	1.300	27.46	71.19	38,136
Group VIII	4,056	2,613	12	307	37,027	243,753	2.268	1.152	25.96	69.99	27,168
Group IX	4,331	3,278	11	303	33,561	245,732	2.583	1.303	23.88	74.42	14,593
Group X	5,836	3,871	13	250	67,196	191,806	2.308	1.651	34.85	61.74	22,672
United States	6,726	4,425	19	479	75,751	487,245	2.167	.941	29.41	68.23	$42,374

line. Assuming that the remaining mileage is capitalized at the same rate, the total capitalization of railroad property in the United States would be $9,871,378,389. The increase in capital for the year ending June 30, 1890, over the previous year, is $538,079,233. Of this amount $250,000,000 at least is due to the increase in capitalization on lines already in existence. The proportion of railroad capital represented by stocks is 46.73 per cent. of the total. The amount of stock per mile of line is $28,193, and the amount of outstanding obligations, including bonds, equipment trust obligations, etc., is $29,250. There are marked differences in the capitalization of railroad property in various sections of the country. In the Middle States, Group II, for example, capital is outstanding to the amount of $117,902 per mile of line. In California, Oregon, Washington and other States and Territories constituting Group X, capital is outstanding to the amount of $87,104. The roads which converge in Chicago, lying east of the Missouri River—that is, Group VI—are capitalized at $47,645 per mile of line, which fairly represents the capitalization in the other sections of the country, exclusive of the Middle States and the Pacific Slope.

	Total.	Per Mile of Road.
Earnings	$1,051,877,632	$6,726
Operating expenses	692,093,971	4,425
Net earnings	$359,783,661	$2,301
Per cent. of expenses to earnings	65.8	....
Interest paid	$229,614,470	$1,468
Dividends paid	89,688,204	574

The capitalization of railroad property is largely in excess of its market value. The interest on bonds and the final net earnings available for dividends may be accepted as the amounts accruing to the owners of railroads on their investment. The amount paid in interest was $229 614,470; the final net earnings were $101,758,587. If the sum of these amounts be capitalized at 5 per cent., it shows that the value of railroad property, considered as an investment, estimated on the operations for the year ending June 30, 1890, was $6,627,461,140, which is equivalent to $42,374 per mile of line.

The total amount of earnings and expenses for the whole country was:

The total traffic of all the roads for the year is given in the following table:

	Passenger.	Freight.
Train mileage	285,575,804	435,170,812
Passengers and tons carried	492,430,865	636,541,617
Passenger and ton miles	11,847,785,617	76,207,047,298
Average train load	41 passengers.	175.12 tons.
Average haul	24.06 miles.	119.72 miles.

The figures for average haul or journey show the great preponderance of local traffic, in spite of the amount of through

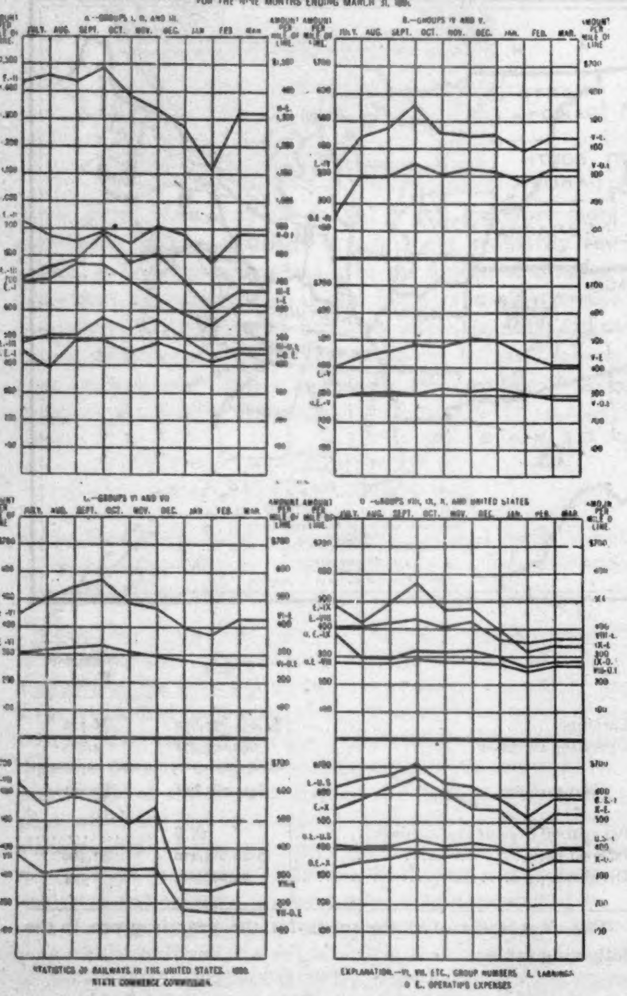
business which is undoubtedly done. Nevertheless, the fact remains that the local business is the mains ay, and where that is greatest the railroads are most prosperous.

The amount paid for rentals does not appear in the statement as given here, except so far as it may have been disbursed as interest and dividends for the lessee companies. The surplus from operations, after paying all charges, appears from the figures in the report to have been $12,070,383.

For the whole country the earnings per passenger mile were 2.167 cents, and per ton-mile 0 941 cent. These figures and averages, however, can best be shown by groups, which is weldone in the accompanying table, taken from the report.

In addition to the information for the year covered by the full report, the Statistician has collected monthly reports of earnings from a large number of companies for the nine months from July 1, 1890, to March 31, 1891, thus practically bringing up certain of the figures to the latter date. Many companies object to monthly statements, believing that they give an incorrect idea of the business of the road, and while we think this is a mistaken idea, it has considerable effect. In the report the results obtained from these monthly statements have been embodied in a graphical form. The accompanying diagrams,

DIAGRAMS SHOWING THE VARIATIONS IN EARNINGS AND OPERATING EXPENSES OF RAILWAYS, BY GROUPS, FOR THE NINE MONTHS ENDING MARCH 31, 1891.



STATISTICS OF RAILWAYS IN THE UNITED STATES. 1890. STATE COMMERCE COMMISSION.

EXPLANATION.—VI, VII, ETC., GROUP NUMBERS. E. EARNINGS. O. E. OPERATING EXPENSES.

taken from the report, show the fluctuations month by month for the roads reporting in each group and for the whole country.

In fuller explanation of the diagrams, perhaps it should be said that each one of the nine columns, when read vertically in any diagram, represents the month named at the top of the column. It will be observed, also, that the "Amount per mile of line" increases at the rate of $100 per square when read from the bottom. Other designations printed on the left and right of each diagram are for the purpose of determining the group (I, II, III, etc.) covered by the irregularly drawn lines, and whether earnings (E), or operating expenses (O. E.), are represented. In reading the illustrations, there should in each instance be compared with the line representing the *earnings* of any particular group the corresponding line representing the *operating expenses* of the same group. In glancing at the line representing earnings for any group for the various months, the influence of harvests and of seasons is clearly shown. Thus, there is to be observed a marked falling off in the months of January and February, while the months of September and October, as a rule, appear to be the most favorable for railroad operations.

Not the least interesting part of the report is that relating to accidents. The total number of persons killed or injured on the railroads for the year may be stated as follows:

	In train accidents.	In operating trains.	At stations, crossings, etc.	Total.
Employés:				
Killed..............	531	1,019	901	2,451
Injured..............	2,588	10,550	9,258	22,396
Passengers:				
Killed..............	113	....	173	286
Injured..............	1,407	....	1,018	2,425
Other Persons:				
Killed..............	346	....	3,252	3,598
Injured..............	492	....	3,714	4,206
Total:				
Killed..............	990	1,019	4,326	6,335
Injured..............	4,487	10,550	13,990	29,027

The most common cause of accident to employés was in coupling cars, in which 369 were killed and 7,473 injured. A very large proportion of the "other persons" killed and injured were trespassers on the track. It will be noted that the proportion of killed among these is very large. An analysis of the report on accidents must be deferred at present, as it is impossible to present it properly in the present article.

The report suggests that the Interstate Commerce Commission recommend Congress to amend the law, so far as statistics are concerned, in three particulars. It suggests, first, that statistics be collected from express companies, which, under the present interpretations of the act, are free from control. The express companies of this country pay to railroads as rentals $20,277,711 a year. They are in reality engaged in the business of quick delivery of freight, and as such should be amenable to control.

It is suggested, in the second place, that the Commission should have the right to call for reports from corporations engaged in the transportation of passengers and freight by water. In 1889 the Great Lakes carried freight which was the equivalent of 22 per cent. of the ton-mileage on all railroads. The shipping lines on the Atlantic seaboard are in many cases links of railroad systems. It is impossible to present comprehensive statistics of transportation unless these lines be called upon for reports.

The third suggestion is, that reports be called for from all companies furnishing rolling stock to railroad corporations, and from all companies providing terminal facilities. These companies own an enormous amount of property, which is property devoted to the business of transportation. It is impossible to make a complete exhibit of the business of transportation unless they make report.

NEW PUBLICATIONS.

THE GREAT LAKES PROBLEM; OR, THE TWENTY-FOOT CHANNEL. By W. A. Livingstone. Detroit, Mich.

This pamphlet, which was especially prepared for the recent Deep Waterways Convention, is a presentation of the importance of the commerce of the Great Lakes, and of the advan-

tages to be secured by the maintenance of a 20-ft. channel and other improvements. It is largely statistical, but the figures are well presented, and a strong argument is made in favor of the betterments proposed.

The pamphlet has also a number of engravings and descriptions of lake carriers, including some of the largest vessels employed.

FIFTH BIENNIAL REPORT OF THE STATE ENGINEER TO THE GOVERNOR OF COLORADO. J. P. Maxwell, State Engineer. State Printers, Denver, Col.

This report, which covers the years 1889 and 1890, is largely devoted to irrigation and the water question, these including the chief work of the State Engineer. A large amount of information has been collected respecting irrigation works completed and in progress, and also in relation to the rivers of the State and their use as sources of water-supply. Much work was done in gauging the flow of streams, and in ascertaining their capacity.

Irrigation was not the only work done, however, and the report refers to State roads and bridges, and to surveys made for the purpose of settling the boundary lines of several counties as well.

PROCEEDINGS OF THE TWENTY-SECOND ANNUAL CONVENTION OF THE MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF THE UNITED STATES AND CANADA. Published for the Association by the *House Painting and Decorating* Publishing Company, Philadelphia.

This volume contains a full report of the proceedings of the convention named, which was held in Washington in September last. It is published in a neat volume, bound and convenient for preservation. The Association is a hard-working one, and its proceedings always contain some papers and discussions of value in their special field. The present volume is no exception, and there is much in it that is worth preserving.

INDEX TO THE FIRST TEN VOLUMES OF SCRIBNER'S MAGAZINE. Charles Scribner's Sons, New York.

The publishers of *Scribner's Magazine* have marked the close of its fifth year by issuing a complete index to the 60 numbers or 10 volumes of the magazine which have so far been issued. This is prefaced by a brief literary and artistic history of the magazine. It will be a very useful help to those who have preserved a file, or who are interested in consulting the magazine for any purpose.

RAILWAY RATES AND GOVERNMENT CONTROL: ECONOMIC QUESTIONS SURROUNDING THESE SUBJECTS. By Marshal M. Kirkman. Rand, McNally & Company, Chicago and New York.

It is quite natural that any one who has made such a careful study of railroad business as Mr. Kirkman has, and who has had so much to do with rates and their results to the railroads, should write upon this subject. It is perhaps natural also that any one in his position should take very strong ground against any control on the part of Government over the making of rates. Not every one will agree with him on this point, and his ground is certainly too advanced, but Mr. Kirkman has reasons for the faith which is in him, and does not hesitate to give them.

It is beyond question that some control is necessary; to a certain extent he is right in deprecating too much interference by Government, but to leave the entire control of the public transportation business to corporations is something which cannot and ought not to be expected from the people after the hard experience which we have had in this country.

That Mr. Kirkman's book is an interesting one need hardly be said. It includes chapters on the Ethics of Transportation; the Basis of Railroad Rates; Special Rates; Pools; Private Ownership; the Limitation of Government Supervision; the Tendency of Government Supervision; the Distinction between Local and Through Traffic and on several other points connected with rates. It has also an appendix giving a condensed statement of the methods pursued in foreign countries, and especially in France and Germany, where the railroad systems are either owned or entirely controlled by the Government. As a fair and reasonable statement of the railroad side of the question, the book is worth reading.

TENTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY TO THE SECRETARY OF THE INTERIOR, 1888-89. J. W. Powell, Director. Government Printing Office, Washington.

Part I. of this report, which relates to the Geological Survey proper, shows the usual record of work done, and the advance made, both in the topographical and the geological work. As the surveys extend greater progress becomes possible, especially in determining the correlation of rocks—that is, the relations among widely separated rock masses. The progress made in geological science is also an assistance in making possible better application of the work done; while, on the other hand, it may be said that the progress of the science has been materially aided by the operations of the Survey.

The special reports accompanying this volume are on the Fresh Water Morasses, with a special description of the Dismal Swamp region; on the Penokee Iron Range in Michigan and Wisconsin, and on the Fauna of the Lower Cambrian Zone. They are all elaborate and carefully worked out monographs, and are accompanied by many illustrations.

Part II. contains the first yearly report of the Irrigation Survey, which was ordered by Congress in 1888, and which was placed under the direction of the Geological Survey. It shows that during the year an excellent beginning was made, and more progress secured than might have been expected in a new undertaking. This included surveys of streams, lakes, drainage basins, etc.; the measurement of rainfall and river flow and examination of the sources of water-supply. Work of this class was carried on in Montana, Idaho, Nevada, California, Utah, New Mexico and Colorado during the year, and some idea of its extent may be given by the facts that 21,766 square miles were surveyed and 127 sites for large reservoirs selected. This work is now being continued.

TRADE CATALOGUES.

A New Method of Making Conventional Signs and a New Lettering Device for Use on Original Topographical Maps. By J. A. Ockerson, U. S. Assistant Engineer. A. S. Aloe & Company, St. Louis.

This is an account of a simple and convenient device for lettering maps or drawings, and of one for making the conventional signs, shading, etc., on maps; both of them seem well adapted for the purposes for which they are designed, and their use will save the engineer and draftsman much tedious and monotonous work. The circular is accompanied by specimens of the work done.

Illustrated Catalogue of the American Steel Wheel Company. No. 1, January, 1892.

This catalogue gives a list of the manufactures of this company, which include not only car wheels, but also locomotive driving-wheels, wheel centers, locomotive truck wheels, steel draw-bars, gear-wheels and special castings for cable railroads, and, in fact, all kinds of steel castings for railroad work. The Company claims that by its methods perfect and solid castings

can be secured, and reports some remarkable tests made of their strength.

Illustrated Catalogue of the Graphite Productions of the Joseph Dixon Crucible Company ; Jersey City, N. J.

This catalogue names a great variety of products from the factory of the Joseph Dixon Company. These include graphite lubricator, both dry for shafts, etc., and in the form of grease for car journals and other bearings ; graphite paint for various purposes ; belt dressing graphite for the bottoms of yachts ; graphite for photographers, for electrotypers and for foundry use ; stove polish ; crucibles ; and last the pencils for which the Company has made such a reputation.

In fact, one must look over this catalogue to realize all the various uses to which graphite can be put.

Illustrated Catalogue No. 2. Frogs, Switches, Crossings, etc. The Weir Frog Company, Cincinnati, O.

This second catalogue of the Weir Frog Company shows a great variety of work, including, besides those named in the table, all kinds of track work and material for steam and street railroads, cable railroad work, portable tracks for contractors, and the like. It includes several new devices, among them a new style of crossing ; several improved switch-stands and a new pattern of split switch.

This catalogue deserves especial mention for its convenient size and the clearness and excellence of the illustrations. It forms really quite a reference-book for track material of all sorts.

The Track Spike, the Tie and the Splice-Bar. Morris Sellers & Company, Chicago.

This pamphlet is chiefly devoted to the merits of the Greer patent spike, and includes descriptions of a number of tests made to show its superiority over the ordinary track spike. These are illustrated by several reproductions of photographs, a few of which are good, while one or two are not—apparently from defects in the original photographs. The tests show very well, however, the points claimed for the Greer spike. A few pages are devoted to the Samson splice-bar, which is now, however, too well known to require much recommendation.

BOOKS RECEIVED.

Transactions of the American Society of Civil Engineers : Volume XXV, No. 4 ; *October,* 1891. Published by the Society, New York.

Transactions of the Canadian Society of Civil Engineers : Volume V, Part I, January-June, 1891. Printed for the Society, Montreal, Canada.

Cornell University, Agricultural Experiment Station : Bulletin 33, *Entomological Division. November,* 1891. Published by the University.

Annual Report of the Postmaster-General of the United States for the Fiscal Year ending June 30, 1891. Government Printing Office, Washington.

Cornell University, Agricultural Experiment Station : Bulletin 34, *November,* 1891. Published by the University, Ithaca, N. Y.

Census of Canada, 1891. *Bulletin No.* 3 : *Population of the Eastern Maritime Provinces.* Department of Agriculture, Ottawa, Canada.

Fifth Annual Report of the Interstate Commerce Commission : December 1, 1891. Government Printing Office, Washington. Some references to this important report will be found on another page.

Report of Tests of a Single-Expansion Ten-Wheel Locomotive on the Baltimore & Ohio Railroad. By David Leonard Barnes. Reprinted from the *Railroad Gazette* by Burnham, Williams & Company, Baldwin Locomotive Works, Philadelphia.

Machinery Pattern Making ; Containing Full-size Profiles of Gear Teeth. By P. S. Dingey. With 376 illustrations. John Wiley & Sons, New York ; price, $2.

Vick's Floral Guide for 1892. *Illustrated.* James Vick's Sons, Rochester, N. Y.

CURRENT READING.

THE beginning of the year, as usual, brings a numerous crop of calendars of all sorts, but the good are in larger proportion than ever before. One of the neatest and most artistic is the Columbus Calendar of the Berwind-White Coal Mining Company, which is really a work of art. Some others worthy of mention are those of the Ashton Valve Company and the Brady Metal Company ; more might be named if space permitted.

Among the books in preparation by John Wiley & Sons, New York, is THE IRON FOUNDER, by Simpson Bolland, which will soon be published.

With the opening of 1892 the STREET RAILWAY GAZETTE, of Chicago, changed from a monthly to a weekly form ; it is now the only weekly paper devoted to this branch. Mr. M. J. Sullivan is now editor, having recently taken charge, and purposes making many improvements. The street railroad interest is an important one, and so good a paper ought to meet with full appreciation and support.

Besides the usual amount of lighter matter, HARPER'S MAGAZINE for February has illustrated articles on the Danube River ; on the Fur Trade of the Northwest and the Hudson's Bay region ; on the Old Shipping Merchants of New York, and on Chicago, the latter by Julian Ralph.

The OVERLAND MONTHLY for January has a number of illustrated articles, including some very fine reproductions of photographs of the moon taken in the focus of the great Lick telescope. The accompanying paper gives an account of some of the work which is being done at the Lick Observatory. There are several historical sketches of much interest, besides a variety of lighter matter. In the February number there is an illustrated account of the ascent of Mount Conness, by Professor George Davidson, the pictures being from photographs taken by the party. There is also a careful and detailed account of the Temescal Tin Mines, about which so much has been said and so little written with authority.

With the January number the journal INDUSTRY, of San Francisco, changes from a page a little larger than our own to the magazine form. In the new form the page is about the size of *Harper's*, and the number before us has 96 pages of reading matter. This paper has always been one with many ideas, and Mr. Richards never fails to give his readers something worth attention. The magazine deserves the success which we hope it will attain.

No. 4, Volume I of the ROSE TECHNIC, issued by the students of the Rose Polytechnic Institute at Terre Haute, Ind., has several excellent articles, and a variety of matter of interest to graduates of the Institute.

The SCHOOL OF MINES QUARTERLY for November has articles on the Intercontinental Railroad, by C. F. Parraga ; the Shadow of a Circle, by A. D. F. Hamlin ; Harbor Improvements on the Pacific Coast, by F. X. Brosnan ; the Filling of Mineral Veins ; Mine Ropes and the Frankfurt Electrical Exposition.

In HARPER'S WEEKLY for December 26 there was an excellent illustrated article on the work now in progress on the power tunnel at Niagara. In the number for January 2 there is an account of the new Drexel Institute in Philadelphia, with a

number of pictures of the Institute. In this number also there is an account of a successful experiment in cultivating lands on Long Island which had always been considered barren and worthless. The number for January 9 has an interesting article on the Revenue Marine and its work, the extent and variety of which is not generally appreciated.

The opening article in the POPULAR SCIENCE MONTHLY for February is on Personal Liberty, by Edward Atkinson and E. T. Cabot It treats of the labor question, giving the results of an exhaustive examination of the decisions of the courts concerning restrictions on hours and modes of labor, regulation of the method of payment, etc. The Pottery articles are continued. The fourth of the Lessons from the Census, by Mr. Carroll D. Wright, is on Urban Population. Professor Jordan writes of the Yellowstone Park, and there are other articles of interest.

The number of the ENGINEERING AND MINING JOURNAL for January 2 is the yearly statistical number; it has 78 pages of reading matter, containing a great variety of statistics of metal and mineral production, the markets for 1891 and similar matters.

The Annual, published on January 1 by the TRADESMAN, of Chattanooga, Tenn., is a valuable number, containing much information about the industries of the South and their growth during the past year. Especial attention is called to the development of the coal and iron industries, and to the great increase in the number of small factories of different kinds.

The special articles in the February number of SCRIBNER'S MAGAZINE include a description of the great Sheep Ranches of Australia, by Sidney Dickinson; an account of the work of the Revenue Marine, by Lieutenant P. W. Thompson, and some results of Explorations in Greenland, by Dr. Benjamin Sharp. The other articles are fully up to the usual standard.

The recent earthquake in Japan is treated in GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for January. There are also articles on Lake Bonneville, on the Names of the Mississippi, on Maps and Map Drawing, and a variety of other topics. The editors evidently believe in short articles, and there are several in this number so interesting that the reader is inclined to wish they were longer.

The February ARENA has articles on the Railroad Problem, by ex-Governor Lionel A. Sheldon; on the Sub-Treasury Plan of the Farmers' Alliance, by C. C. Post, and on the Electoral College, by R. S. Taylor. There are a number of other articles deserving attention in the number.

The JOURNAL of the Military Service Institution for January has articles on the Terrain in Military Operations, by Lieutenant Reed; A United States Army, by Lieutenant Batchelor; Rapid-Fire Guns, by Lieutenant Van Deusen; Discipline and Tactics, by Captain Harris; Reminiscences of Tonquin, by Lieutenant Cloth. There are also a number of reprints and translations of interest.

In the COMPASS for January there are articles on Speedy Calculators; on the Plain Transit; on Position Finders, and a continuation of the very interesting papers on Series of Numbers.

Among the articles in the ENGINEERING MAGAZINE for January are the World's Store of Tin; Art and Engineering at Tuxedo Park; the Rights of the Lowest Bidder—an interesting subject for contractors; the Paper Making Industry; Sewage Disposal; Type-setting by Machinery, and the second of Dr. Coleman Sellers' papers on American Supremacy in Mechanics.

A NEW venture in the magazine field is GOOD ROADS, the first number of which was issued in January, by the League Roads Improvement Bureau, under the editorship of Mr. Isaac B. Potter, and which is to be devoted to the cause of better roads. The first number contains a variety of excellent matter, including a number of engravings taken from photographs and showing the actual condition of some common roads, which is contrasted by showing highways in England, France and Italy. There are several articles on the road question, including one on the Personal Labor Tax System. This magazine has a large field before it, and can do excellent work and promises well for the future.

The number of the AMERICAN AGRICULTURIST for January marked the beginning of the second half century of that excellent periodical. It is a very handsome number, with a large number of engravings, and contains, besides the articles which will interest readers generally, a valuable statistical review of the crops and live-stock of the country, past and present, including a number of new figures from the last Census. A careful estimate of the prospects for the future, with especial reference to the farmer, is another article which will attract attention. Age, apparently, has only increased the vigor of our contemporary.

THE BERLIN BRIDGE COMPANY'S SHOPS.

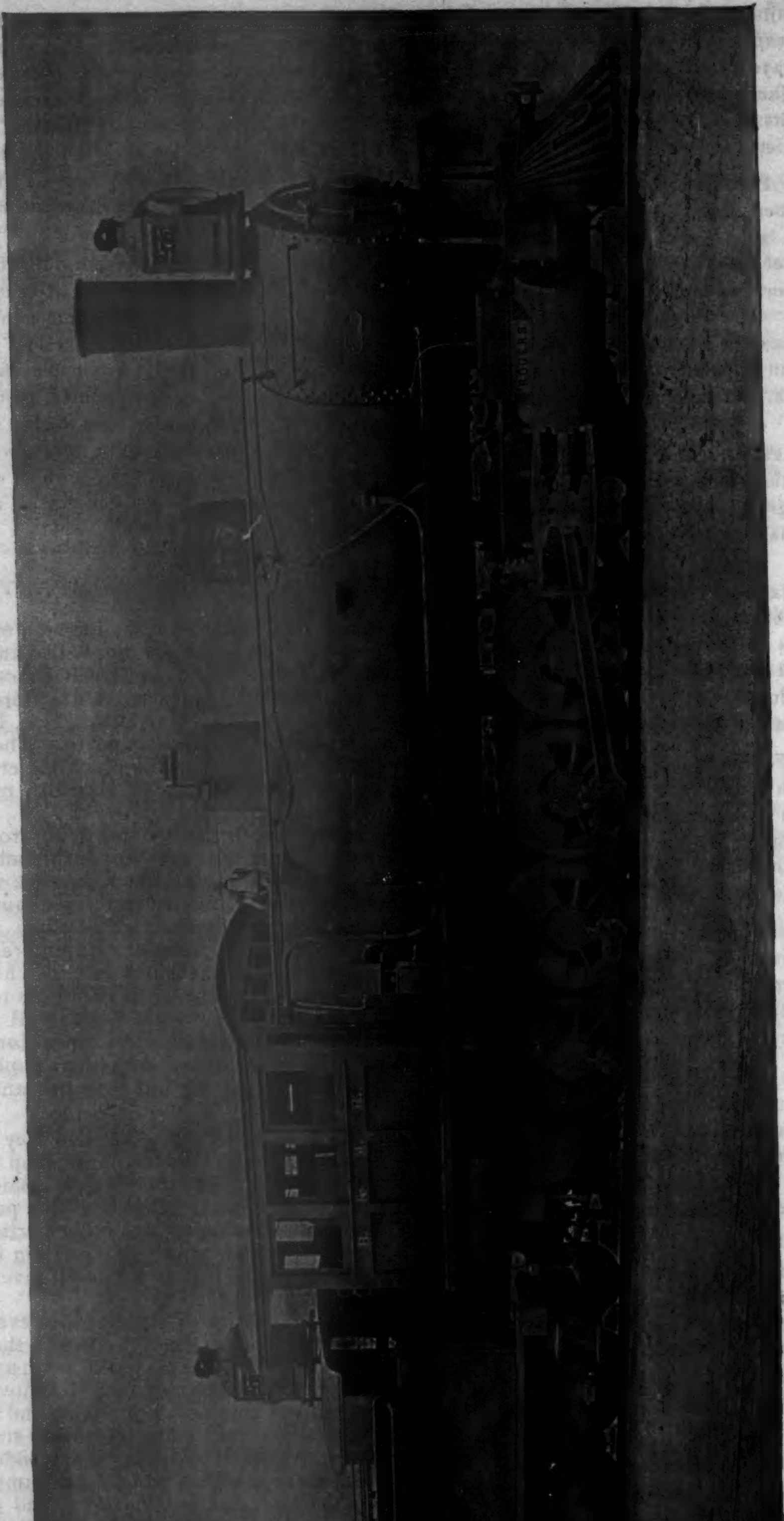
To those not familiar with the location of this enterprising Company's establishment, nor with Yankee geography, it may be said that Berlin, or Berlin Junction is a station on the New York, New Haven & Hartford Railroad between New Haven and Hartford. This, however, is not the location of the shops referred to. They are at East Berlin, a flourishing village on the Middletown Branch of the New York, New Haven & Hartford road, and about five miles from Berlin.

These shops are organized for doing iron bridge, roof, and building work, and are admirably adapted for that purpose. Between 300 and 400 men are now employed, and about 20 draftsmen. Everything about the establishment is thoroughly systematized. When an order is received it is assigned a number and entered on a book in which the principal dimensions and the chief characteristics of the work are entered. It then goes to the drawing-room and is completely worked out in all its details. A little book accompanies the drawings into the shop in which all pieces are entered with their dimensions. This forms a guide in getting out the work and also in shipping it.

When the drawings go into the shop they are taken first to the template floor. This is a large shop with abundant floor room on which the roof or bridge is laid out full size, and wooden templates are made of all the parts, with rivet holes bored and dimensions and other particulars marked on them. This is not required for certain kinds of work, such as pin-connected bridges, but all riveted structures are laid out in this way.

The principal feature of interest, however, to a visitor to this establishment, is the new bridge shop, which is a model of its kind. It is 80 × 400 ft., with an annex which forms the boiler and engine-house. Narrow-gauge tracks extend through the shops longitudinally, and are connected with the other shops and yard. The first stage in getting out work is to lay it off from the wooden templates. Each hole is marked with a punch, the number of the job painted on the plate bar, or "shape," and other facts of importance are indicated. The members then go to the shears, which are located at the north end of the building, and are cut to the required form and size. They are then moved southward to the punches, after which they are assembled and riveted together. After they are punched they are carried on tracks elevated about two feet and a half above the floor, or at a convenient height for the workmen.

The lower chords of the roof trusses are formed of built-up I beams, which carry transverse trolleys for moving heavy parts. Longitudinal tracks are also supported from the roof and carry trolleys, so that any part of the floor can be reached by the two systems. The south end of the shop is provided with small traveling cranes carried



TEN-WHEEL "PUSHER" LOCOMOTIVE FOR THE BURLINGTON & MISSOURI RIVER RAILROAD.

BUILT BY THE ROGERS LOCOMOTIVE & MACHINE WORKS, PATERSON, N. J.

on longitudinal beams. These in turn are carried on wheels which run on the lower chords of the roof trusses. The longitudinal beams are made in separate sections, so that they can be moved transversely on the roof chords. In this way the cranes command the whole floor area of this part of the shop. The material enters the shop at the north end and is kept moving southward between all the stages of completion, and is carried out at the south end when finished to a yard outside of the shop provided with cranes for handling heavy work and placing it on cars for shipment.

A very commendable feature in this shop is the great amount of light which is provided. The roof trusses are supported by built-up wrought-iron columns, and all the space between them, excepting that about eight feet from the floor, is enclosed by window sashes. The space below the windows in winter is enclosed by removable wooden sections which are put up in winter and taken down in summer. Besides these windows there are abundant skylights glazed with ribbed or "hammered" glass to exclude sunshine. This building shows the impossibility of getting too much light into a workshop. It is difficult to emphasize too much the importance of an abundance of light in such buildings. Insufficient light is one of their most common defects. It seems as though most of those who design shops "love darkness better than light."

The heavy tools, such as punches, shears, etc., are by Bement, Miles & Company. Several fixed vertical riveting machines are used, but for heavy work Allen's portable pneumatic machines are employed. The management of these works report a fair amount of work on hand, but it is too early to foretell the prospects of the new year.

A HEAVY "PUSHER" LOCOMOTIVE.

THE accompanying illustration is from a photograph of a very heavy locomotive recently built by the Rogers Locomotive & Machine Works, Paterson, N. J., for the Chicago, Burlington & Quincy Railroad, for service as a pusher or helping engine on a heavy grade, and now employed in such service on the Burlington & Missouri River Division of that road.

Among the peculiar points of the engine may be noted the absence of a truck, throwing the entire weight on the driving-wheels; the large boiler capacity; the use of the Belpaire fire-box, in which the crown-bars are dispensed with and the fire-box crown-sheet supported by radial stays to the outer shell; and the large grate area.

The boiler of this engine is 68 in. diameter of barrel at the smoke-box end; it has 229 tubes 2¼ in. in diameter and 14 ft. 6 in. long. The fire-box, which is, as noted above, of the Belpaire type, is 11 ft. long by 41 in. wide inside; it is 61⅝ in. in depth at the front end, and 59½ in. at the rear end. The grate area is 37.5 sq. ft.; the heating surface is: Fire-box, 180 sq. ft.; tubes, 2.172 sq. ft.; total, 2,352 sq. ft. The fuel used is Iowa coal. The usual working pressure is 160 lbs.

The entire weight of the engine is carried on the 10 drivers, which are 50 in. in diameter. The wheel centers are 42 in. in diameter, and the tires, of steel from the Latrobe Works, are 4 in. thick. Eight of the wheels have flanged tires; the tires of the middle pair are plain, and are 6¾ in. on the face. The total wheel-base is 17 ft. 10 in., and the wheels are spaced equal distances apart. The driving axle journals are 8 in. in diameter and 8¾ in. long.

The parallel rods are of the solid-end pattern, bushed. The main connecting rod is fluted, and of the usual strap end pattern. The driving-springs are from the A. French Company. The cross-head is of the "alligator" pattern, with the guides above and below, as shown.

The cylinders are of unusual size, being 22 in. in diameter and 28 in. stroke. The steam-ports are 1⅝ × 17½ in., and the exhaust ports 3¼ × 17 in., the bridges being 1½ in. wide. The valve-motion is the shifting link type; the eccentrics are 5 in. throw, and the valves have 5 in. travel in full gear. The valves are the Richardson balanced valve. The steam-pipe is 7 in. in diameter. Jerome's metallic packing is used in the stuffing-boxes.

The smoke-stack base and cylinder head covers are of pressed steel. The engine is fitted with the Westinghouse automatic tender and train brakes, and with the American equalized driver brakes.

The total weight of the engine light is 134,000 lbs. The total weight in service is 150,300 lbs., giving an average of about 7½ tons per wheel.

The tender is carried on two four-wheeled trucks. The tender axle journals are 4¼ in. in diameter and 8 in. long. The tank has a capacity of 3,480 gallons of water.

SOME CURRENT NOTES.

THE Deep Water-ways Convention at Detroit was largely attended, and was a body fairly representative of important interests. The resolutions passed urge upon Congress the importance of completing a 20-ft. channel from Duluth and Chicago to Buffalo; of making at once surveys for a ship canal from Lake Erie to Lake Ontario, and from Lake Ontario to tidewater; and of the improvement of the Hudson River to secure a 20-ft. channel to Troy. More liberal appropriations for lighthouses, buoys, etc., for the Lakes were asked for. Incidentally the Pennsylvania plan for a ship canal from Lake Erie to the Ohio was approved.

THE latest bridge over the Ohio River has just been completed by the Edge Moor Bridge Works, of Wilmington, Del., at Kenova, W. Va., for the Ohio extension of the Norfolk & Western Railroad. This bridge is 1,730 ft. long over all, and has five spans, all through truss; two of the spans are 301 ft. each, two 304 ft. each and the channel span 521 ft. On the West Virginia side the approach consists of an iron viaduct 2,150 ft. long.

NEW FERRYBOATS FOR THE HOBOKEN FERRY.

By JAMES J. GANNON.

THE satisfactory performance of the *Bergen*, the first of the twin-screw type (launched October 25, 1888), during a service of two years actual running has encouraged her projectors to build two more of the same class. The adoption of this class of boats by other companies bids fair to pronounce them past an experimental stage. The excellent engraving on the following page is from a sketch of the *Bremen on her trial trip;* we are indebted for it to the courtesy of our contemporary, the *Seaboard.*

The *Bremen* and *Hamburg* are larger than the *Bergen*. The *Hamburg* is an exact duplicate of the *Bremen*. The former is nearing completion at the company's yards in Hoboken, while the latter is in service on the ferry. The hulls of both boats were built by T. S. Marvel & Company, Newburg, N. Y. They are constructed of steel. The following are the dimensions in comparison with the *Bergen:*

	Bergen.		*Bremen.*
Length over all	200 ft.	0 in.	222 ft.
Beam	62 "	0 "	62 "
Draft	8 "	9 "	11 "
Depth of hold	17 "	0 "	17 "

The two new boats are double decked. The upper saloon is 97 ft in length by 36 ft. in width and 10 ft. in height. Extending all around it is a promenade hood butting against the pilot-houses, giving it a graceful appearance. The lower saloons are 157 ft. in length, with an average width of 15 ft., the height being 13 ft. A double stairway leads from the lower saloons to the upper ones, the seating capacity being 450 persons.

Each boat has an inverted, direct-acting, compound condensing engine of about 1,475 maximum H.P., the high-pressure cylinders being 20 in. in diameter and the low-pressure cylinders 36 in., having a stroke of piston equal to 28 in.

In the *Bergen*, an inverted, direct-acting, triple-expansion condensing engine is used, with a high-pressure cylinder of 18½ in. in diameter, an intermediate of 27 in. diameter, and a low-pressure cylinder of 42 in. in diameter. Attached to the cross-head of the low-pressure cylinder is an arm to work the air-pump. This arrangement is dispensed with in the new boats, they having an independent air and circulating pump, with compound steam cylinders,

the high-pressure being 7 in. in diameter and the low-pressure 14 in. in diameter, having a stroke of 16 in. In this system we are enabled to get up a vacuum in the cylinders before the engine is started, thus relieving the pressure of the atmosphere from the other side of the pistons. This cannot be obtained in an air-pump attached to the main engine before the engine is started.

The seats for the salt-water valves in the circulating pump are formed in solid composition plates instead of seats driven into cast iron. The piston and piston-rods are of composition, and the air and water cylinders are lined with composition. This extra amount of valve area permits the pumps to be run at a high rate of speed.

The valves for the main engine are of the piston type, set with a travel of 14 in. for the high-pressure cylinder, and 18 in. for the low-pressure cylinder. They are worked by the Stephenson double-bar link, which is connected to the rocker shaft by means of a rod attached to each side of the link, and in turn connected to an arm keyed on the shaft.

The initial steam pressure in the main engines will be 125 lbs. to the square inch, furnished from two horizontal boilers 9 ft. 1 in. in diameter and 21 ft. long. Each has two corrugated furnaces 44 in. in diameter. The total grate surface is 100 sq. ft. The boilers were tested to 250 lbs. hydrostatic pressure. The shell is composed of ⅞-in. steel. The tubes are 2 in. in diameter. In a short time, when the engines get settled down, the steam pressure may be reduced to 85 lbs. pressure to the square inch.

The reversing engine is placed in front of the main engine, parallel, and bolted to the engine column. It is operated in the ordinary manner.

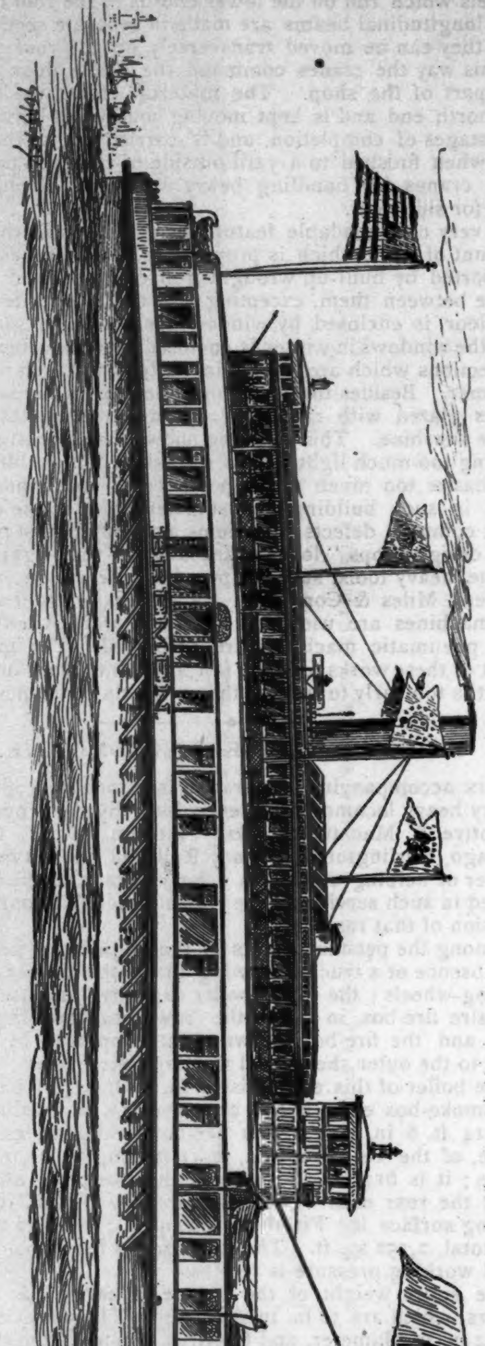
The steam for the main engines is regulated by two balanced throttle valves in the steam pipe, one leading into the high-pressure cylinder of each engine. The throttle lever is attached to a shaft working in four bearings, which are bolted to the cylinders; the shaft runs from one high-pressure cylinder to the other, where, by means of a lever at each end, attached to arms keyed on the shaft, it transmits motion to a small shaft working in a bearing, which in turn regulates the valve. By moving the throttle lever, which is connected to the shaft, steam enters both high-pressure cylinders at the same time.

The diameter of the crank-shaft is 9¼ in., which runs the entire length of the boat. The cranks are placed 180° apart in each engine, so that when the engines are coupled together the center line of cranks in one engine will be perpendicular to the center line of cranks in the other, so that, practically, the cranks stand 90° apart. With this arrangement, smoothness of running is assured, while the engines can be started from any position, it being impossible to be caught on the centers. There is also little vibration felt, owing to the fact that each crank balances the other.

The steering gear comprises two Williamson steam-steering gear, one placed in the forward compartment of each boat. Each engine has two cylinders, the cranks being set 90° apart. By means of gear wheels a drum is revolved around which chains are wound, leading in opposite directions, working on slides. A number of small pulleys communicate motion to a large wheel of about 60 in. in diameter which is fastened perpendicularly to the rudder post, the chain in turn passing around the wheel. The rudder is of the balanced type, the hull being cut away to receive it. The front end of each rudder is cut on a line with the bow, giving an easy and graceful curve, and practically forming a part of the bow. With a rudder of this type it is obvious, providing enough power is applied to it, the amount of water dispensed with on either side is greater than that of a rudder half out of water.

The trial of the *Bremen* has already taken place. The trip comprised, to Newburg and return, a distance of about 120 miles. The indicated horse-power developed registered 1,475 maximum. A mile was made in 3 minutes 7 seconds. While in service on the ferry she will develop about 750 I.H.P.

These engines were built by the W. & A. Fletcher Company, of Hoboken. To these successful engineers great credit is due for the successful performance of this boat. The pumps, etc., were furnished by the Blake Manufacturing Company, of New York.

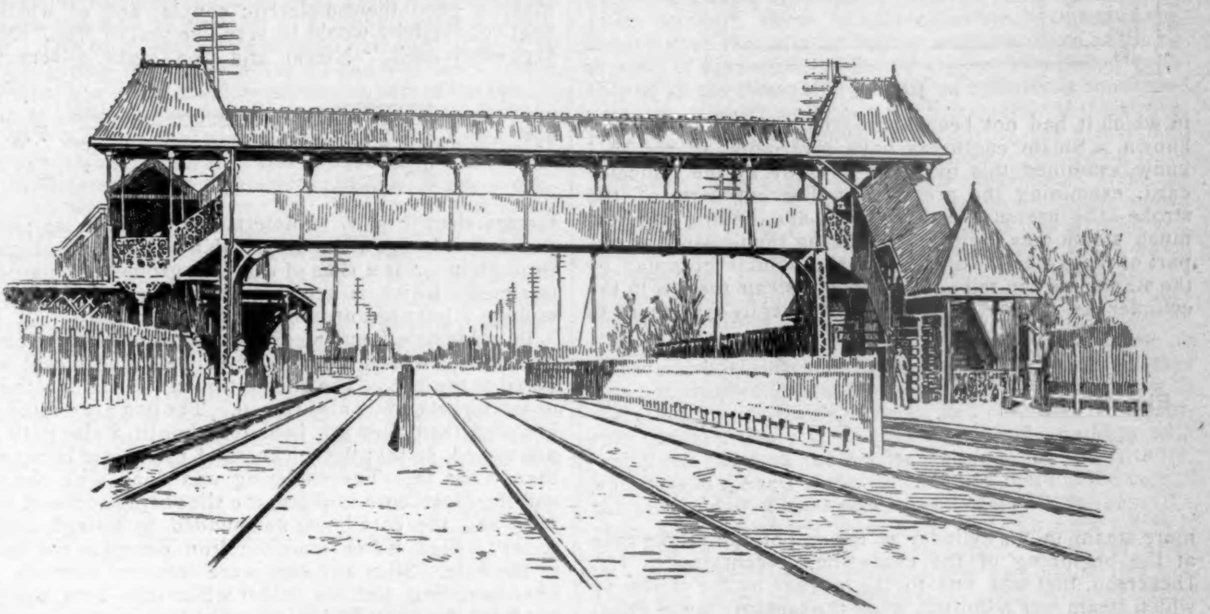


DOUBLE-SCREW FERRYBOAT "BREMEN," HOBOKEN FERRY.

THE BEDFORD PARK FOOT-BRIDGE.

THE accompanying sketch shows a very neat foot-bridge which has lately been erected at Bedford Park station, on the Harlem Division of the New York Central & Hudson River Railroad. Bedford Park is one of the prettiest of the recent suburban settlements around New York; it is on the west side of the Harlem Railroad, just above the old village of Fordham, while on the east side of the road is the new Bronx River Park, owned by the city of New York.

The station is on the west side of the railroad, which has at that point four tracks, the two outer ones being used by the local trains, which stop at the station, and the two inner ones by express trains. The north-bound platform being on the east side of the tracks, a bridge was necessary to enable passengers to cross in safety, and one has been built, which is shown in the sketch, and which harmonizes well with the station and its surroundings.



FOOT-BRIDGE AT BEDFORD PARK STATION.

The bridge is a single span of 60 ft.; the two plate girders are supported on two columns at each end. The girders, which are spaced 8 ft. 6 in. apart between centers, form the railings, and the floor is carried on the lower flanges. The stairways on either side are supported by cast-iron columns. The bridge itself and the stairways are covered by a roof of ornamental design, carried on light iron columns.

This station, it will be noticed, is fenced in, and fences are placed to prevent persons from crossing the tracks on a level. This is the general practice followed on the Harlem line at the suburban stations.

In addition to the usual local traffic at this station, there is in summer a large number of passengers going to and from the Bronx Park; this is likely to increase, as the park becomes better known and the plans for its improvement are carried out.

A THERMO-ELECTRIC METHOD OF STUDYING CYLINDER CONDENSATION IN STEAM ENGINE CYLINDERS.

(Paper read by Professor Edwin H. Hall before the American Institute of Electrical Engineers; from the *Transactions* of the Institute.)

THE subject of cylinder condensation is one that possibly would come more aptly before the mechanical engineers than before the electrical engineers, and yet most electrical engineers are to a greater or less extent mechanical engineers, and the time seems not yet to be near when we can dispense with the steam-engine in the practical application of electricity. The methods for turning the energy of coal directly into electric currents, I believe, have not yet been put into application. The subject of cylinder condensation is one that has always been prominent in the study of the steam-engine. Before the time of James Watt, as you are all aware, at every stroke the cylinder was filled with steam and then it was cooled down by pouring water on the outside or by admitting water into the inside, so that whenever the steam was admitted it found the cylinder cool. A large part of the steam admitted at every stroke was turned into water at once on admission, and some of it was doubtless turned back into steam during the stroke, but much of it went out as water in the end. Watt introduced the independent condenser by means of which the steam is removed from the cylinder without cooling the latter down as it was cooled before; and yet, it is still believed that a very considerable part of all the steam that enters the cylinder is condensed upon the inner surface of the cylinder; that some of this is reevaporated during the stroke, but that a very considerable part remains as liquid at the end of the forward stroke and is only turned back into steam during the back stroke, when it is a disadvantage rather than an advantage, for it has to be expelled by the returning piston. It is considered that in some engines as much as 25 per cent. of all the steam that enters the cylinder goes through the cylinder as water—that is, during the forward part of the stroke. Writers upon steam engineering have devoted a good deal of attention to discussion of the cause of cylinder condensation, with perhaps less attention to suggestions for remedy. The cause of cylinder condensation is that when the cylinder is thrown into communication with the condenser, rapid evaporation takes place of the water remaining on the wall, and that rapid evaporation under the diminished pressure cools greatly the cylinder wall.

A little over two years ago Mr. Dickerson, of New York, gave an address before the Electric Club, in which he advanced the proposition that the peculiar character of the indicator card of a steam-engine, which was supposed to show cylinder condensation and re-evaporation, was due to leakage by the valves—leakage in at one part of the stroke and leakage out at another. He made the statement that steamboats in the waters about New York would travel four or five miles an hour with the valve between the boiler and the cylinder closed. I do not know how accurate that statement was, but I have never seen it contradicted.

Interest was excited by this paper, and I knew that steam engineers were by no means agreed as to the amount of

condensation, or as to what caused the cylinder condensation, some believing that the steam coming in at A, fig. 1, was cooled by contact with a layer of water remaining over from the previous stroke—the layer of water upon the inside of the cylinder. They thought that you could hardly account by the action of the iron alone for the very sudden condensation of the large amount of steam that is condensed. Mr. Dickerson's paper, then, stimulated me to undertake an investigation of this matter in a direction

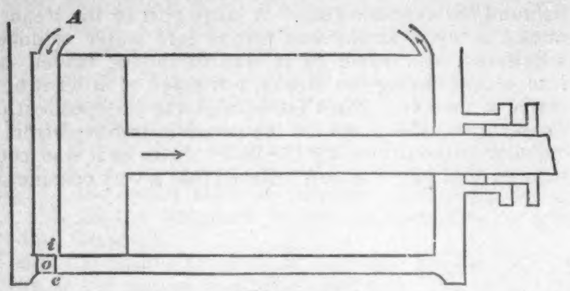
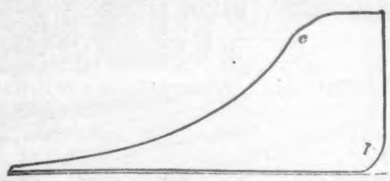


Fig. 1.

in which it had not been approached before, so far as I known. Steam engineers have invariably, so far as I know, examined this question by study of the indicator card, examining the pressure at different parts of the stroke—the pressure and volume—and finding out how much steam they indicate. Knowing the pressure at this part of the stroke C (fig. 2), and the volume occupied by the steam, we can tell what weight of steam there is in the cylinder as *steam*. It is found frequently that there is

Fig. 2.



more steam in the cylinder at the end of the stroke than at the beginning of the expansion. According to Mr. Dickerson, that was due to the leakage by the valves by which steam was admitted, when the pressure in the cylinder fell low. It seemed to me that we might test the question how much heat enters the cylinder wall by a thermo-electric method. Let the line $i\ e$, fig. 1, represent the thickness of the cylinder wall. At O is a hole which in the engine which I have used is bored for attaching the indicator. It is a hole about ½ in. in diameter. The thickness of the wall is a little over ¾ in. I screwed a plug, fig. 3, having at one end i, a slice of iron—I used steel at first—of known thickness. There are two holes going through

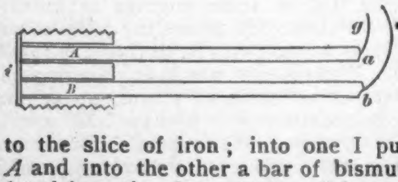


Fig. 3.

the plug to the slice of iron; into one I put a bar of antimony A and into the other a bar of bismuth B, both being insulated from the plug. It is well known that bismuth and antimony make an excellent thermo-electric pair—the best that is in practical use. If I connect the antimony with the copper wire g, the bismuth with the copper wire c, and lead those wires to a galvanometer, I shall get a current through that galvanometer whenever the two junctions here, a and b, are at a different temperature from the section where the antimony and the bismuth strike this slice of iron. If I put the ends of these rods of bismuth and antimony into a pot of paraffin and heat that paraffin, when I get the temperature of these two junctions, a and b, where the copper joins the bismuth and antimony, the same as the temperature where the antimony and bismuth strike the iron, the current will cease. If the temperature here is below the temperature there, I get the current in one direction. If the temperature here is higher than the temperature there, I get a current in the opposite direction.

That was the beginning of the method. But it presently occurred to me that it would not do to use bismuth and antimony, for the reason that the heat conductivity of those substances is too different from that of iron. My purpose was to find what the temperature was at a certain thickness in the cylinder wall at a certain part of the stroke. I close the circuit $g\ c$ at a particular part of the stroke by means of a cam upon the crank. I can close the circuit at any part of the stroke for a short time.*

It being my purpose to find what the temperature is at a particular depth in the iron, I wished to have that temperature as exactly as possible what it would be if this iron were in a normal condition—that is, if this were in a solid cylinder instead of being in a prepared plug. To get that I found it necessary to have for the bars, A and B, fig. 3, a heat conductivity which was more nearly like that of iron than the heat conductivity of antimony and bismuth is. So I cast about for some metal which would *with iron itself* make a good thermo-electric couple, and of which the heat conductivity would be very like that of iron. Nickel suggested itself. Nickel and iron make a very good

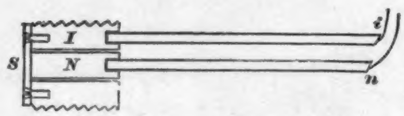


Fig. 4.

thermo-electric pair. I determined to make my plug in this way. In fig. 4 is a plug with a hole bored completely through it. S is a slice of cast-iron ground to a particular thickness, which is screwed on at the end of the plug, making a joint meant to be steam-tight.†

Into this hole I put a core of nickel insulated from the iron except where it strikes the slice. The nickel is soldered to the iron. The slice is tinned very thinly; the end of the nickel core is also tinned. The two are heated very hot and then they are held together in a vise until they are cooled, so that the thickness of the solder is not more than 0.001 in. The soldering was done with the slice and the nickel core in place, the slice being screwed to the plug and the core being surrounded by a single layer of paper to keep it free from the iron, except at the bottom of the hole. Slice and core were removed from the plug after soldering, and the solder which had been squeezed out from the joint by the action of the vise was carefully turned off in a lathe. The distance from the outer end of the core to the further surface of the slice was measured carefully before soldering and after soldering. In no case did these measurements show the thickness of the solder to be as much as 0.02 mm. We know very definitely, then, the depth at which the contact takes place. By experiment, I found that the heat conductivity of nickel is perhaps 15 or 20 per cent. less than that of cast iron,‡ but still nearer the heat conductivity of cast iron than any other metal that I could get that would make with iron a good thermo-electric junction. The specific heat of nickel is near that of iron, which again is as important, perhaps, as the matter of the thermal conductivity.

Now from the nickel core I led a nickel wire, both being made from the same bar of which I had determined the conductivity; from the iron an iron wire. This and the one of nickel were slender bars about 15 cm. long rather than wires proper; see fig. 4. These are not drawn to scale. The junctions i and n were put in a pot of paraffin, and I went through the processes which I have indicated already.

I had three plugs like this made. With one the slice of iron was 0.051 cm. thick, with the other, 0.101 cm. thick, with the other, 0.203 cm. thick. Let fig. 2 be the indicator

* In my latest experiments the fly-wheel has made about 60 revolutions per minute, and contact has lasted about $\frac{1}{60}$ part of a revolution. The cam pushes two pieces of brass together without touching either of them directly. Springs hold the two slips of brass apart when the cam is not acting.

† In some of the experiments this joint was not perfectly tight, for *water* was sometimes seen to come out by the *core n* before the plug became hot. Generally upon such occasions the leaking appeared to cease when the plug became hot. The fact probably is that the joint continued to leak slightly, but leaked *dry* steam, the temperature at the outer end of the plug being about 109° C., and at the inner end considerably higher. Both experiment and reason indicate that the effect of such leakage upon the temperature found was slight.

‡ The nickel used was of fair commercial quality. I am not yet prepared to publish details of the measurement of its conductivity.

card from the engine with which we are making this test. I used first the plug with the thinnest slice, and I found the temperature at this depth of iron, ½ mm., at that part of the stroke, *k*, fig. 2, just before steam is admitted. I did the same with the 1-mm. slice and with the 2-mm. slice. Let the line *D*, fig. 5, represent 4 mm. of the thickness of the cylinder-wall, points at depths of ½ mm., 1 mm., and 2 mm., being marked upon it. Now I plot a curve. Let me say that a part of this is prophetic; this curve I haven't been able to plot perfectly. Suppose that distances out to the left from the line *D* represent excesses above 109° centigrade, that being the temperature of the outer surface of the cylinder wall. With the ½-mm. slice at the part of the stroke, *k*, fig. 2, I find an excess above 109° of 8° or 9°, which I will represent by the distance *a*. With the 1-mm. slice I find the temperature to be greater at this part of the stroke, and I will represent the excess above 109° by the distance *b*. With the 2-mm. slice the temperature was not very different from what it was with the 1-mm. Through the tops of the lines *a*, *b*, and *c* I draw a curve. What I wish to do some time is to be able to plot a curve like that giving the temperature all the way down inside the wall of the cylinder at this particular part of the stroke.

I made similar determinations for that part of the stroke *c*, fig. 2. I found the temperature at ½ mm. depth had risen to 131°, more or less. The temperature at the depth of a millimeter was a little higher. This point, ½ mm. deep, had already begun to cool. The fact is that in my engine the cut-off is, as shown in fig. 2, pretty gradual, so that re-evaporation very likely begins before cut-off is complete. I suspect, however, that 131° is too low for the temperature at a depth of ½ mm. At the depth of 2 mm. the temperature was not as high as it was at a depth of 1 mm. At the depth of 2 mm. in the iron there was, however, a jump of some 4° to 5° centigrade.

One of these curves, shown in fig. 5, represents the condition of things at this part of the stroke *k*. The other curve represents the condition at that part of the stroke marked *c*. The curves are by no means accurate and they

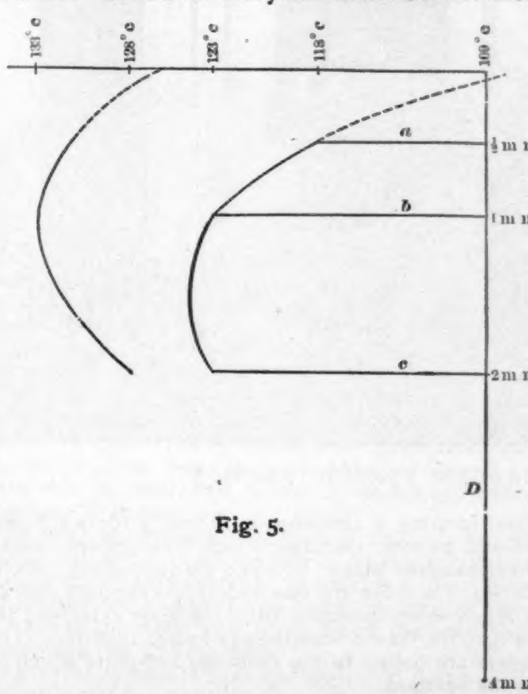


Fig. 5.

are very incomplete, but supposing them made perfect, I have merely to put on a planimeter to measure the area between the two curves, and it is then easy to determine how much the heat in the cylinder at the part *c* of the stroke exceeds the heat at the part *k*, and this excess of heat is the heat which has been given up by the steam to the cylinder wall, which has been done during the admission. Allowance should be made, of course, for the loss through the wall meanwhile. Then I can compare the result with the indicator card and see whether the two are in agreement.

I have made some tests for points at other parts of the stroke. I found, as I have already stated, that at ½ mm. depth the temperature at cut-off has already passed the maximum, that it falls rapidly down here during expansion, and at this part of the stroke near release, it is only a few degrees higher than at the end of the exhaust. But the parts deeper in the cylinder are, of course, slower to cool. In fact, the heat rushes into the wall here during admission; then as soon as the pressure is relieved the water begins to evaporate from the inner wall and the heat ebbs back and is spent, some part of it, in forming steam during the expansion, but not all of it. A considerable part remains at the end of the stroke to be spent in evaporating water which is still clinging to the wall of the cylinder.

As I have said, this research is by no means complete, but it has gone far enough to indicate that a very large quantity of heat goes into the cylinder wall. A very rough calculation from my experiments indicates that in the engine* I am using (Kendall & Robert's 10-in. cylinder with 15-in. stroke); about two-thirds as much steam is condensed upon the cylinder wall as remains active at the beginning of expansion. I should say that two-fifths † probably of all the steam that enters that cylinder is condensed upon the cylinder wall upon the first quarter of the stroke. How much of that is reevaporated during the stroke, and so helps more or less, I do not yet know. According to the indicator cards taken during the experiments with the plugs, the weight of steam in the cylinder at the end of expansion is about 1.25 times as great as just after cut-off. How much heat is absorbed by the layer of water which remains over from the previous stroke, I cannot tell. I think there is some evidence that a layer of water does remain over from the previous stroke. This examination shows, however, that the iron is exceedingly effective in cylinder condensation, and it suggests the question whether it is not possible to coat the inner wall of the engine with something which would prevent, to a considerable extent, this condensation. It is not easy to find anything with which one can coat the rubbing surfaces of the cylinder, but there is the end of the cylinder and there is the face of the piston, and those two surfaces make, in the case of a short cut-off, perhaps more than half the area which is effective in this cylinder condensation. It is not at all impossible that some comparatively non-conducting material can be found with which those surfaces can be coated so as very materially to decrease the cylinder condensation. Experiments for that purpose could easily be made with plugs of this kind. Instead of having to coat the whole cylinder, this plug might have some non-conducting material laid on it, and we might see how much difference that would make in the amount of heat absorbed. Something valuable might come out of it, and a very large aggregate saving in the steam used in steam-engines might perhaps be made in this way.

The research of which I have here given an account has been carried on with money from the Rumford Fund of the American Academy of Arts and Sciences. For indispensable assistance in the investigation I am indebted to Messrs. Barron, Curtis, Hale, Kendrick, and Page, members of a class at Harvard College engaged in a study of the steam-engine.

ARMY ORDNANCE.

THE report of the Board of Ordnance and Fortification, which has been submitted to Congress by the Secretary of War, is dated October 30 last, and states that the total amount appropriated subject to the supervision of the Board to date is $11,385,332, and in addition thereto the sum of $3,500,000 will be required to fulfill the contract with the Bethlehem Iron Company, approved by the Board.

In regard to the Watervliet Gun Factory, the Board says that, when completed, as contemplated by the Act of 1891, the factory will be equipped for manufacturing all calibers up to and including 12 in., and the building will be adapted to receive machinery for finishing and assembling 16-in. guns should Congress hereafter authorize their con-

* This maximum pressure I get here, fig. 2, is about 33 lbs. above atmospheric, and I use an expansion of about 3¾ and about 60 strokes to the minute.

† This is very likely an overestimate; perhaps one-third would be safer.

struction. The Board has carefully considered this question of additional machinery, and is strongly of opinion and recommends that it should be of a size adapted to finish and assemble the 16-in. gun.

Contracts have been entered into for 73 sea-coast mortars, and the sum of $325,000 has been appropriated for the construction of carriages for the same. The modern high-power breech-loading rifled mortar, of about 12-caliber length of bore, being an entirely new arm in our service, carriages of greater strength and endurance than any heretofore in use, capable of resisting the immense strain of firing a projectile of upward of 600 lbs. weight at a great angle of elevation, had to be devised, constructed, and tested. Two types of carriages for these heavy rifled mortars, which are to constitute such an important part of our system of defense, have been purchased under allotments recommended by the Board, and both are now at Sandy Hook. In conclusion the report says:

"There are now certainly two great plants where forgings up to 12-in. guns can be turned out with reasonable dispatch, and a gun factory where they can be finished and assembled. Types of 8-in., 10-in. and 12-in. guns have been completed, and either tested or are awaiting proof. It is expected that by January 1, 1893, the factory will have turned out nine 8-in., five 10-in. and two 12-in. guns. Eleven guns of 8-in. caliber are under contract with the West Point Foundry. One hundred guns of 8-in., 10-in. and 12-in. caliber are practically under contract with the Bethlehem Iron Company. Seventy-three 12-in. sea-coast mortars are under contract or completed.

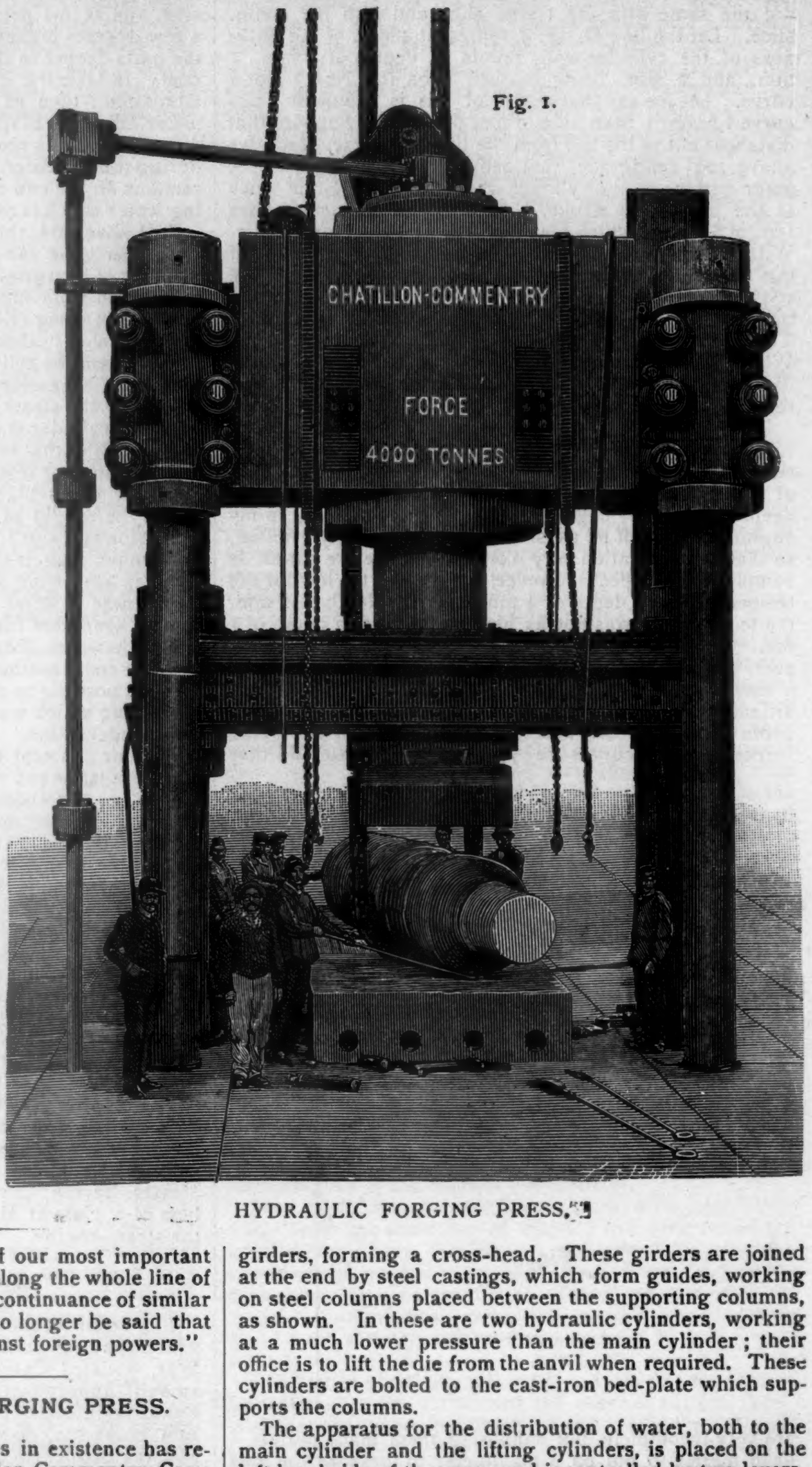
"Types of gun and mortar carriages have been procured and are undergoing tests; considerable success has attended the efforts to produce an American slow-burning prismatic powder that shall render the United States independent of foreign manufacturers; a beginning has been made on the construction of gun and mortar batteries for the protection of our most important ports, while advance has been made along the whole line of defensive preparation. Four years' continuance of similar legislation and activity, and it can no longer be said that the United States is defenseless against foreign powers."

A LARGE HYDRAULIC FORGING PRESS.

One of the largest forging presses in existence has recently been erected by the Chatillon-Commentry Company, at its St. Jacques Forge, at Montluçon, France. This machine is intended to make the heaviest forgings, and can exert a pressure of 4 000 tons. The accompanying illustrations, from *le Genie Civil*, show, in fig. 1, a general view of the press; in figs. 2, 3 and 4 a front elevation, side elevation and plan respectively.

The anvil-block has a separate foundation. The upper frame and large hydraulic cylinder are carried by four steel columns, joined at the top by castings and heavy bolts. The ram or die, which corresponds to the hammer-head in a steam hammer, is attached to two steel

Fig. 1.



HYDRAULIC FORGING PRESS.

girders, forming a cross-head. These girders are joined at the end by steel castings, which form guides, working on steel columns placed between the supporting columns, as shown. In these are two hydraulic cylinders, working at a much lower pressure than the main cylinder; their office is to lift the die from the anvil when required. These cylinders are bolted to the cast-iron bed-plate which supports the columns.

The apparatus for the distribution of water, both to the main cylinder and the lifting cylinders, is placed on the left-hand side of the press, and is controlled by two levers, which are placed within easy reach of the hammer-man.

The pumps are driven by a steam engine with two cylinders, which is capable of working up to 500 H.P. The cylinders are 43.3 in. in diameter and 43.3 in. stroke; the valve-gear is the Meyer adjustable cut-off. The cranks on the main shaft are set at right angles. In addition to the cut-off valves, the steam pressure can be closely regulated by the engineer, a lever conveniently placed working a valve in the main steam-pipe.

The high-pressure pump is 5.5 in. in diameter, and the plunger has a stroke of 43.3 in. Ordinarily this pump is run at the rate of 20 strokes per minute when the press is at work.

The accumulator is rectangular in form, and is of heavy steel plates and angles; it is 9 ft. × 12 ft. in size and 16 ft. Water is forced into the lifting cylinders with a pressure of 710 lbs. per square inch.

The forging press is placed in a building erected for it; this building is entirely of iron, and 177 ft. long and 72 ft. wide, with a clear height of 50.5 ft. under the roof trusses. The heating furnaces are placed at one side of this build-

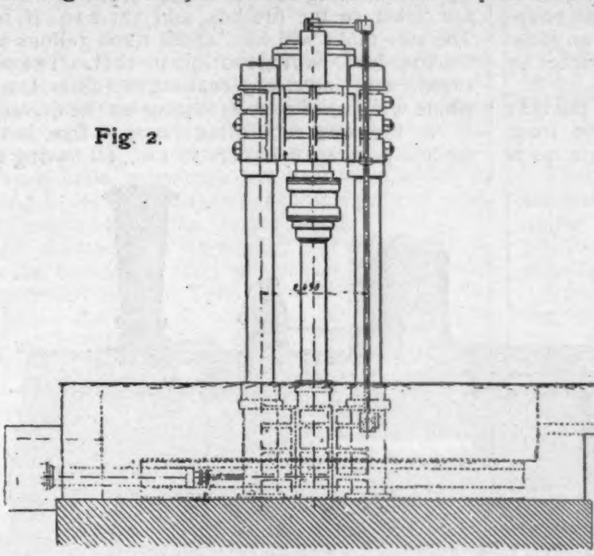


Fig. 2.

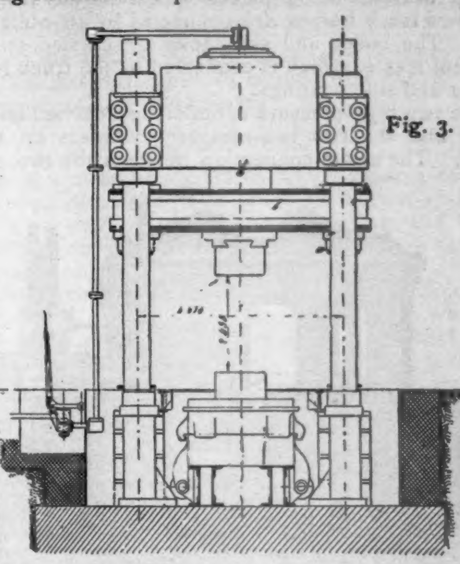


Fig. 3.

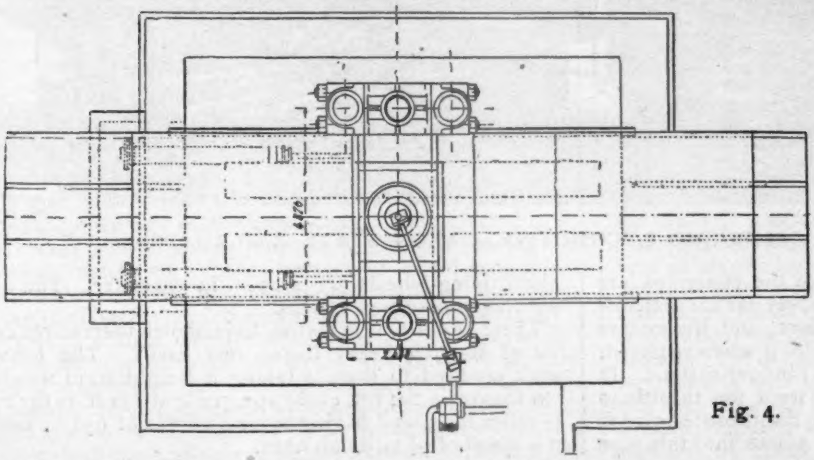


Fig. 4.

HYDRAULIC FORGING PRESS.

ft. high, and is loaded to a weight of 180 tons. It is solidly joined to three plungers, each 8.85 in. in diameter and having a stroke of 108.27 in. These pistons work in heavy cylinders of cast steel set in a bed-plate prepared for them. By an arrangement of two valves the water from the pumps can be turned into one of these cylinders alone, into two of them, or into all three at once. In this way the pressure on the main cylinder of the press, and consequently on the ram, can be made 2,075 lbs., 3,110 lbs., or 6,220 lbs. per square inch, as three, two, or one of the accumulator cylinders may be in use.

With such enormous pressures, it will readily be understood that all the connections had to be made very heavy, and the greatest care exercised in packing. The piston of the main cylinder is packed with heavy cup-rings of leather. The walls of the steel cylinders in which the accumulator pistons work are 3.78 in. thick.

To prevent accidents from the too rapid descent of the accumulator, it has a system of counterbalance weights to prevent it from descending too far. It is also furnished with a trip which, should it pass a certain point, acts on a lever which closes the steam valve, at once stopping the engine and the pumps.

The two hydraulic cylinders which lift the ram work at a much lower pressure. The pumps supplying them are driven by a separate engine having two cylinders 12 in. in diameter and 18 in. stroke. These pumps are connected with an accumulator which consists of a steel cylinder 9.84 ft. in diameter and 12.3 ft. long, connected with a plunger 18 in. in diameter and having a stroke of 34.26 ft.

ing, and are so arranged as to give the most convenient access. At one end of the main building is a wing or annex of the same length, but of somewhat less width and height; in this are placed the engines, pumps, accumulators and boilers.

The press is served by two traveling cranes, one of 40 tons and one of 75 tons capacity. The tracks on which these cranes run are supported by iron columns. The shop is lighted by electric lights. The arrangements are such that the heaviest forgings can be handled without difficulty.

The first work done with this press was the forging of some heavy steel armor-plates of peculiar shape for the new battle-ship *Brennus*. It is to be used for armor-plate, gun-forgings, large shafts and similar work, and for roughing or squeezing down large ingots.

In relation to the use of this and similar presses, reference may be made to M. Chomienne's discussion of the hammer and the press, which was published in the JOURNAL for August, 1889, page 353, in Notes on Steam Hammers.

A FOUR-CYLINDER COMPOUND LOCOMOTIVE.

IN the paper on compound locomotives by M. Mallet, which was published in the JOURNAL some time ago, reference was made to the four-cylinder double-truck type of engine adopted by the Decauville Works, on some of the French departmental lines and on the Gothard Railroad.

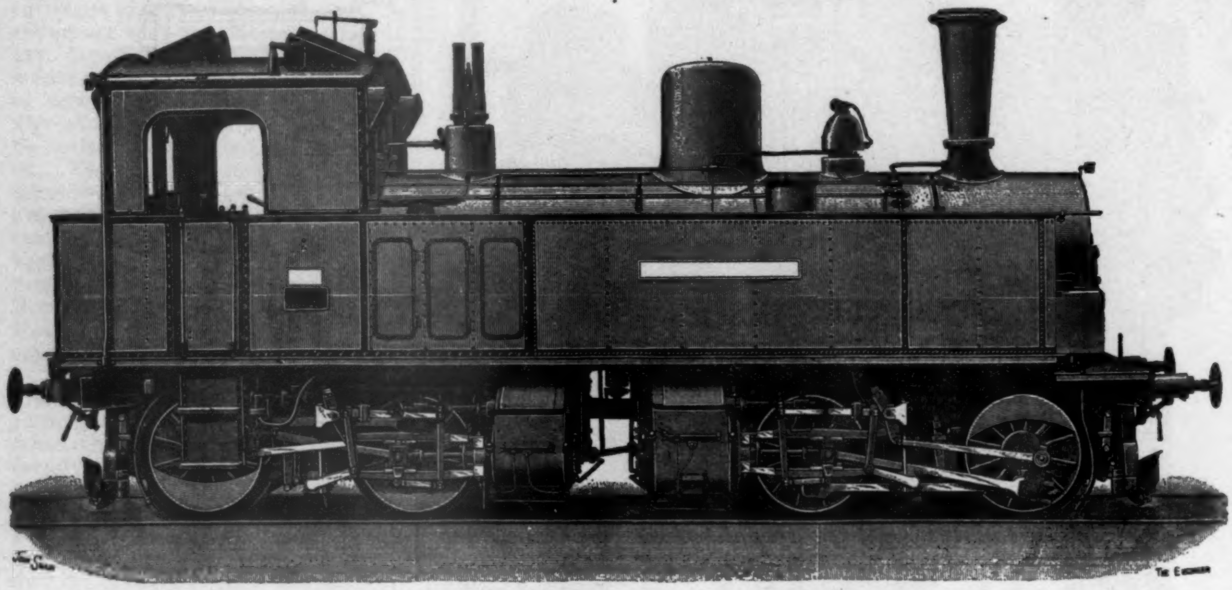
The accompanying illustration, from the *Engineer*, shows an engine of this type, one of several recently built for the Saxon State Railroads by the Chemnitz Engine Works.

This engine, as will be seen from the general view, is carried on eight wheels, all driving-wheels, each set or group of four being placed in a separate truck frame. The two truck frames are connected by an oblique coupling. The boiler and side-tanks are carried on an independent frame, which is connected to the truck frames by center and side bearings.

The two high-pressure cylinders are carried on the rear truck and the two low-pressure cylinders on the front truck. The steam connection between the two groups is of back-pressure from the receiver, with a corresponding decrease of the power exerted on the drivers. This equalization of the effort on the two pairs of pistons is claimed as an important advantage.

The boiler of this engine has 14.75 sq. ft. grate area; the total heating surface is 930 sq. ft., of which 58.2 sq. ft. are direct, in the fire-box, and 871.8 sq. ft. in the tubes. The side tanks will hold about 1,200 gallons of water, and the coal-box about 4,000 lbs. of coal. The weight of the engine with tanks and coal-boxes full is 112,400 lbs., the whole weight, of course, resting on the drivers.

The high-pressure cylinders are 11.8 in. in diameter and the low-pressure cylinders 18.1 in., all having 21 in. stroke.



FOUR-CYLINDER COMPOUND LOCOMOTIVE, SAXON STATE RAILROADS.

shown in section in fig. 2, in which the couplings are shown. This pipe *F* serves as a receiver for the exhaust steam from the high-pressure cylinders, and live steam from the boiler can also be admitted to it when required.

The starting-gear employed is the Lindner system. In this an auxiliary steam-pipe *A* runs from the throttle to the steam-pipe or receiver *F*. When the throttle-valve is opened one-half or more, live steam passes into this pipe *A*, in which a four-way cock is fitted, so connected with the reversing lever that the movement of the latter when placed in full gear, either forward or backward, opens the cock and admits live steam to the receiver *F*, and so to the low-pressure cylinders; this supply is shut off when the reversing lever is in any other position. The point of cut-off when the reversing lever is in full gear is about 70 per cent. of the stroke. No live steam can pass into the receiver except when the reversing lever is at the point named, no matter how far the throttle-valve is opened.

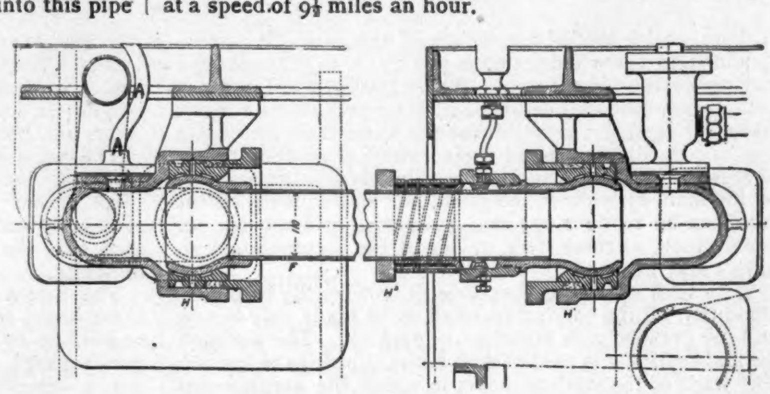


Fig. 2.

The valve-gear used is the Walschaert gear, and is so arranged that the point of cut-off for the high-pressure and the low-pressure cylinders is the same for any degree of expansion in both forward and backward gear. The ratio between the high and the low-pressure cylinders is 1:2.35. It is claimed that any slipping of the low-pressure driving-wheels will be stopped at once, because while the slipping is going on the steam required for the low-pressure pistons will exceed the amount delivered from the high-pressure cylinders, and the effect on the driving-wheels of the low-pressure truck will decrease. In the same way, if any slip should occur with the high-pressure truck wheels, it will be quickly stopped, because then more steam would be going from the high-pressure cylinders than the low-pressure cylinders could receive, and there would be a rapid increase

The driving-wheels are 43.3 in. in diameter. The usual working pressure is 170 lbs.

These engines, it is stated, have shown themselves capable of starting heavy trains very easily. The heaviest work credited to them is taking a freight train weighing 150 tons (of 2,204 lbs. each) up a grade of 132 ft. to the mile, 3½ miles long, and having several curves of 656 ft. radius, at a speed of 9½ miles an hour.

Whatever opinion may be held as to the compound feature of these engines, the great objection remains of the complicated system of steam pipes and connections involved in the double-truck form of locomotive. It may be doubted whether the gain claimed for the compound system will counterbalance the increased first cost and expense of maintenance of this type.

The Chemnitz Works are building 10 more engines of the same type for a road of 1 meter gauge; they are lighter engines than the one described above, having cylinders 9.5 in. and 14.6 in. in diameter, 30-in. driving-wheels, and weighing 55,100 lbs. in working order.

NOTES ON COMBUSTION.

By C. Chomienne, Engineer.

(*Continued from page 26.*)

LIQUID FUEL.

Heretofore we have only considered solid fuel, and especially coal; and we can hardly speak by experience of heating with liquid hydrocarbons. Their use, considering the heating effect, is more costly at present than that of coal, and it has only been rarely attempted in France.

Among liquid fuels, petroleum has been used widely in Russia, owing to its low cost and the high price of coal, and to some extent also in the United States.

It has been claimed that its employ will be greatly increased by the success of the processes for making solid petroleum invented by MM. Terrier and Mercier. In this it is obtained in the form of briquettes of a size easy to handle and sufficiently hard to enable them to be loaded and unloaded and to stand transportation well. In this state it will take fire only in contact with the flame; it burns easily, and its heating effect is about twice as great as that of coal, while the refuse or ash is very small in quantity. Moreover, it will not become liquid again until it is subject to a temperature of 100° C.

There are certain cases in which the use of liquid fuel may be very advantageous, especially where it is sometimes necessary to increase the production of steam quickly, which would be difficult with most boilers, were coal alone used. By combining the use of coal with that of some liquid fuel the latter becomes a useful auxiliary, coming in as a regulator, and permitting on occasion a considerably increased production which can be stopped when desired. In such a case the liquid fuel should be brought to the surface of the fire-box with the air necessary for its combustion, by means of an injector of some form, and so arranged that it will take fire at once as it is distributed from the openings of the apparatus. This injector is fed by steam which passes through it, and on leaving the opening meets an annular current of liquid fuel, mixed with which it passes into the fire-box. Under this action, if the injector is properly arranged, a strong draft of air is created. With proper apparatus of this kind, the quantity of fuel fed may be regulated by the movement of a valve, and in this way we can control absolutely the production of steam. In England an arrangement of this kind has been applied to locomotives using petroleum refuse, and has enabled the engineer to secure a considerable increase in the production of steam when it is needed on heavy grades or in running against a strong head wind.

Petroleum has been studied by M. St. Clair Deville, and some of the results obtained by him are given in the table below:

Kind of Oil.	Density.	Actual Calorific Effect.	Composition of Oil.			Calculated Calorific Effect.*
			C.	H.	O.	
White Oak, W. Va., distilled...	0.819 at 13° C.	10,104	85.3	13.9	0.8	11,626
Burning Spring, W. Va., dist'd..	0.762 at 14.2° C.	10,146	84.0	14.4	1.6	11,681
Oil Creek, Pa., crude............	0.816 at 0° C.	9,887	82.0	14.8	3.2	11,588
Heavy Oil, Parisian Gas Co., distilled from coal...............	1.044 at 0° C.	8,849	82.0	7.6	10.4	8,797

*This Calorific Power is calculated by the formula $8080\,C + \left(H - \frac{O}{8}\right) \times 34{,}500$.

It will be seen from this: 1. The calorific effect of liquid hydrocarbons increases as the proportion of hydrogen is greater.

2. That the calculated calorific effect differs from the actual result less when the proportion of hydrogen is smaller or the density greater.

If we take a coal developing 7,000 *calorics*, there will be required to replace 1 kg. of mineral oil at 11,000 *calorics*:

$$\frac{11{,}000}{7{,}000} = 1.57 \text{ kg. of coal.}$$

The sum required to obtain the same amount of heat, taking the respective prices at 0.02 franc per kilogramme of coal and 0.30 franc for the same weight of oil, will be:

For coal: 1.57 kg. × 0.02 fr. = 0.0314 fr.
For oil: 1.00 kg. × 0.30 fr. = 0.3000 fr.

That is, the cost of oil will be nearly 10 times that of coal. This last result will, of course, vary widely, as the relative costs of coal and oil vary.

GASEOUS FUEL.

There is a class of apparatus which secures complete consumption of smoke—that is the gas-burner—but it requires in a general way continuous working, and the applications which have so far been made of it have not given satisfactory results in heating boilers.

Gas not having a sensible radiating power, direct heating surface has not the importance which it has with solid fuel, and the result is that the average production per square meter of heating surface is less than with solid fuel. Moreover, when we have coal of fair quality it seems better to burn it directly upon the grate, since the loss due to producing gas from this coal varies from 17 to 25 per cent., depending on whether the tar is saved or not. On the other hand, gas furnaces can work with coal containing 30 per cent. and more of cinders, which can be bought at a very low price, and the use of which on an ordinary grate would be impossible, even with artificial draft.

Anthracite coals also work very well with the gas producer. Lignite, turf or peat, wood and other fuels can also be employed with the gas producer, especially after they have been dried.

If the gas generator is placed too far from the boiler we lose a part of the heat produced in the generator itself—that is, all the radiated heat plus the sensible heat of the gas. This can be avoided if the generator is placed near the boiler, separated from it only by the combustion chamber. By this arrangement we can utilize the sensible heat of the products of distillation, which is considerable, and we obtain from an equal weight a gas richer in combustible elements and having a greater heating power. It is necessary in this case to use forced draft as much as possible, and to use a jet of warm or heated air in the fire-box, which will produce full combustion of the gases, and will give the flame a direction toward the end of the fire-box opposite the door, while at the same time it will preserve the plates against too rapid action of the flame.

The air forced under the grate may be regulated by a valve easily worked by the firemen. It will aid in the decomposition of the fuel while passing over the bed of burning coal, from which the gas is produced.

This air is first transformed into carbonic acid—an incombustible gas—but in passing over the upper layers of coal it gives up one equivalent of carbon, and is transferred into carbonic oxide, which is a combustible gas. Gas obtained from coal of fair quality in the Siemens gas generator, with natural draft and without any injection of water or steam, has a composition varying as follows:

In volume.

CO	22 to 28 per cent.	Combustible elements.
$C_2H_4 + H$	9 to 14 " "	
CO_2	4 to 6 " "	Inert gases.
Nitrogen	54 to 67 " "	

The heating power of the cubic meter, calculated by Dulong's law, varies between 1,000 and 1,300 *calorics*.

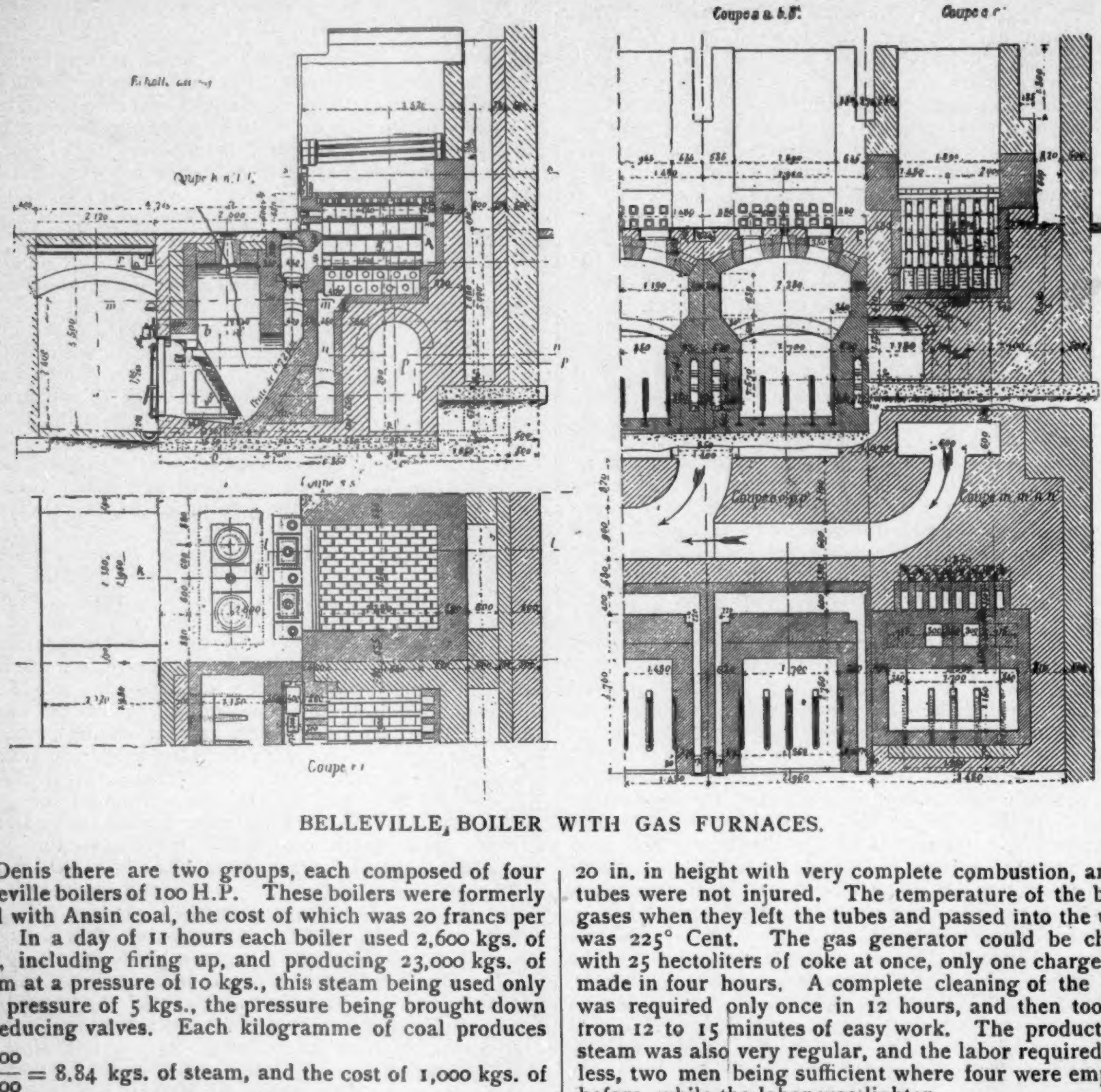
It is necessary that the flame obtained by the injection of heating air into the combustion chamber should be prolonged almost the whole length of the boiler, and this long flame can be obtained only by preserving the parallelism of the veins of gas and air in order that the oxidation—that is, the combustion, may last as long as possible; but as at the end of this reaction the gas is poor in combustible elements and the air has lost most of its oxygen, while carbonic acid and nitrogen are in large quantity, we must have a great excess of heated air in order to keep up

throughout the whole extent of the flame a temperature favorable to the combustion of the remaining traces of combustible elements. For this purpose we require a special form and arrangement of fire-boxes, but this point, I believe, has not been sufficiently considered, and to this neglect is due the poor success obtained in many cases with this apparatus.

We will now describe an application of the gas generator to boilers, with the object of doing away with the ordinary grate, pointing out at the same time the reasons for its adoption and the results. In one of the large factories at St. Denis there are two groups, each composed of four Belleville boilers of 100 H.P. These boilers were formerly fired with Ansin coal, the cost of which was 20 francs per ton. In a day of 11 hours each boiler used 2,600 kgs. of coal, including firing up, and producing 23,000 kgs. of steam at a pressure of 10 kgs., this steam being used only at a pressure of 5 kgs., the pressure being brought down by reducing valves. Each kilogramme of coal produces $\frac{23,000}{2,600} = 8.84$ kgs. of steam, and the cost of 1,000 kgs. of steam was therefore $\frac{2,600 \times 20}{23,000} = 2.26$ francs.

An attempt was made to use gas-coke with the object of replacing the coal. This coke contained 10 per cent. of water and 10 per cent. of cinders, leaving 80 per cent. of combustible matter. It was in large pieces, generally free from dust, and its price was only 17 francs a ton, delivered in the boiler-room. It was found that this coke obliged the firemen to charge and clean their fires about three times as often as with the coal. The heat radiated from the fire injured their eyes, and the lower rows of tubes were burned out in a few months; for these reasons it became evident that the use of this coke on an ordinary grate must be given up.

M. Lencauchez being consulted proposed to replace the ordinary grates in the second group of boilers with gas generators burning this same coke, and he was asked to make the change without altering the boilers. The arrangement which he adopted is shown in the accompanying engraving, which shows the plan and several sections of the boilers and fire-boxes. The results obtained were that 2,000 kgs. of coke produced 15,000 kgs. of steam at a pressure of 10 kgs. Each kilogramme of coke, therefore, produced $\frac{15,000}{2,000} = 7.50$ kgs. of steam, and the cost of 1,000 kgs. of steam was $\frac{2,000 \times 17}{15,000} = 2.26$ francs, or the same as with the coal.



BELLEVILLE BOILER WITH GAS FURNACES.

With the new arrangement there was a short flame about 20 in. in height with very complete combustion, and the tubes were not injured. The temperature of the burned gases when they left the tubes and passed into the uptake was 225° Cent. The gas generator could be charged with 25 hectoliters of coke at once, only one charge being made in four hours. A complete cleaning of the grates was required only once in 12 hours, and then took only from 12 to 15 minutes of easy work. The production of steam was also very regular, and the labor required much less, two men being sufficient where four were employed before, while the labor was lighter.

A regulator of the Belleville type, worked by the pressure of the boiler, maintained a constant pressure of 10 kgs., whether the demand upon the boiler was for 10 or 65 H.P., the production being automatically stopped when the engine stopped. This register opens and closes the draft as the pressure increases or lowers. With this arrangement, also, it was found that a body of fuel kept at a red heat will replace within certain limits, with tubulous boilers, the stored-up steam and water contained in ordinary boilers. This was due in part to the use of the regulator.

The first group of four boilers continued to be run with coal, the gas generator having been applied to the second group only. From the figures given above it was evident that the second group produced steam only in the proportion of 15 : 23, or about 34.8 per cent. less than the other, but the cost of 1,000 kgs. of steam was the same for each group of boilers—that is, without deducting the cost of the alterations, which were considerable. More-

VALUES OF DIFFERENT GASEOUS FUELS.

KIND OF FUEL.	Gas obtained from 1 Kg. of Solid Fuel. Weight. *Kilogrammes.*	Gas obtained from 1 Kg. of Solid Fuel. Volume at 0° Cent. & 0.76. *Cubic Meters.*	Heat Disengaged by Combustion of Gas from 1 Kg. *Calorics.*	Heating Power of the Solid Fuel. *Calorics.*	Loss due to Gasification. *Per cent.*	Relative value of the fuels treated, as compared with gas coal.
Coke made in coke ovens	.....	5.000	4,500	7,000	36	0.927
Gas coke	5.325	4.260	4,260	6,400	33	0.878
Anthracite and dry coals	6.330	5.075	5,075	7,500	32	1.046
Coking and gas coals	4.116	3.520	4,850	6,600	27	1.000
Common lignite with 40 per cent. water	1.669	1.460	2,090	3,375	38	0.431
Average peat, with 18 per cent. water	2.110	1.770	2,375	3,250	28	0.490
Wood, with 25 per cent. water	1.930	1.615	2,390	2,900	18	0.493

over, the gas generator permitted the use of a fuel which could easily be procured in large quantities in Paris.

The analysis of the gases as they pass out of the generator give the following results :

CO	21.76
H	10.83
C_2H_4	1.10
C_4H_4	1.38
CO_2	3.57
Nitrogen	61.36
Total	100.00

The heating power of a cubic meter at 0° Cent., and a pressure of 0.76 was found equal to 1,210 calorics. The heat lost in making the gas was 18 per cent., and the cost per cubic meter under the conditions named was 0.008 franc. It is to be observed that the gas generators did not work continuously, but only in the daytime. This was a serious drawback, and with continuous working the results would doubtless have been better.

We ought to say that the use of the gas generator being adopted with certain fuels, calculations should be made for the maximum production of steam, since with coal we can sometimes, without loss and with due regard to economy, drive the boiler a little. This is an advantage in certain cases, but is almost impossible when the gas generator is used.

One drawback to the use of gas generators in heating boilers consists in the great increase of cost and in the necessity of deep foundations, which in some cases cannot be had.

The accompanying table shows the results obtained with the generator using different kinds of fuel :

CONCLUSION.

A careful study of the question of combustion has resulted in the conviction that to secure that economy, which is desirable in order to use properly our store of coal, to prevent it from being exhausted, and to reduce the expenditure in producing steam, we need above all things to properly instruct the firemen upon whom so much depends with any system of boilers and furnaces. It is too often the case, with stationary boilers especially, that this work is entrusted to ignorant men who do not understand the first principles of the work which they are required to do. It has often appeared to the writer that it would be of great benefit to owners of boilers if schools for firemen could be formed where they could receive elementary instruction to fit them for their duties. This would benefit very greatly the workmen themselves, as well as the owners of boilers, and the results would seem to be desirable in every respect. In France this could be done by the district associations of owners of steam boilers ; in other countries other agencies would have to be adopted, according to the local circumstances in each case.

If we except those cases, which really are unusual and only occasionally found, where boilers have been constructed or set up from designs radically wrong, there is one rule that can be universally applied—a good firemen is the best possible coal-saving device.

THE COLUMBIAN EXPOSITION.

THE main building, for the exhibition of Manufactures and the Liberal Arts, which is said to be the largest building of the kind ever planned, is 1,687 ft. long by 787 ft. wide, its greatest dimensions being north and south. It covers an area of 30½ acres. It is rectangular in form, its central hall being surrounded by a nave and two galleries. The feature of the building is the great central hall. It has a clear space of 1,280 × 380 ft. Its roof rises to a height of 245½ ft. at the apex, and the 380 ft. space is covered by a single-arched span, without a supporting column. The height from the floor to the center of the arch is 201 ft. clear, and the height of the lantern above the arch is 44½ ft. Twenty-two steel arches support the center of the roof. Each arch weighs 125 tons, and more than 5,000 tons of steel enter into the construction of the hall. Extending around the hall is a gallery 20 ft. from the floor. It is 67 ft. wide, 21 ft. of this space overhanging the floor of the hall. The total length of this gallery is 3,504 ft. Beyond the gallery, and extending around the central hall, is a nave 108 ft. wide and 114 ft. to the apex of the roof. The east and west halls of this nave are 1,588 ft. long, and the total length of the nave, on the center line, is 4,119 ft. Extending entirely around the nave, and to the outside line of the building, is a gallery 20 ft. from the floor, and 49½ ft. wide. The two galleries are connected with 28 bridges, 50 ft. high and 108 ft. long. There is a fraction less than 11 acres of skylight in the roof, requiring 41 car-loads of glass. There is in the floor and galleries a little more than 41 acres of space. There will enter into the construction of this building more than 1,600 car-loads of material. The building occupies a most conspicuous place in the grounds. It faces the lake, with only lawns and promenades between. North of it is the United States Government building, south the harbor and water basin, and west the Electrical building, and the lagoon separating it from the wooded island. The building will cost $1,500,000.

THE rules governing exhibits in the Department of Transportation, and the classification adopted for that department, have been published in pamphlet form. In this section there will be seven general groups :

Group 80. Railroads, Railroad Plant and Equipment.
Group 81. Street Car and other Short Line Systems.
Group 82. Miscellaneous and Special Railroads.
Group 83. Vehicles and Methods of Transportation on Common Roads.
Group 84. Aerial, Pneumatic and other forms of Transportation.
Group 85. Vessels and Boats—Marine, Lake and River Transportation.
Group 86. Naval Warfare and Coast Defense.

The last-named class—Group 86—will not include our own Navy, whose exhibit will be made in the Government Building.

The main building and annex for the Transportation Department will have over 17 acres of floor space, and will have tracks, transfer-tables, and other facilities.

ENGINES OF AN ENGLISH CRUISER.

(From *Industries.*)

THE accompanying illustrations show the engines of the new cruiser *Naiad* of the English Navy, fig. 1 being a front elevation and fig. 2 an end view. This vessel, with her two sister ships *Latona* and *Melampus*, form three of the 17 vessels given out to build by private contract under the Naval Defense Act of 1889, and were built by the Naval Construction & Armaments Company, Limited, of Barrow-in-Furness.

The *Latona* and *Melampus* were delivered very early, the former vessel being finished considerably within the contract date, thus enabling her to be taken to the Mediterranean on an experimental cruise, and afterward to join in the naval manœuvres of 1891, in both of which tests she acquitted herself satisfactorily. The leading dimensions of the *Naiad* are common to the other two vessels, the length being 300 ft.; beam, 43 ft.; and depth to the upper deck, 22 ft. 9 in.; the displacement at the mean draft of 16 ft. 6 in. being 3,400 tons. The stem and stern frames are of cast steel, with apertures to admit torpedo tubes. The vessels are provided with double bottoms, which under the engines and boilers are used as fresh-water feed tanks for supplying the boilers. There are 16 transverse bulkheads extending to the upper deck. The protective deck, formed of 1-in. steel plates on the flat part and 2½-in. steel plating on the slopes, extends throughout the ship to 4 ft. below the water-line, covering the boilers, magazines and torpedo-rooms, and partially enclosing the engine space. The crown of the deck is 1 ft. above the water-line.

The vessel has been divided into 80 water-tight compartments, and for the better protection of the engine-room an armored breastwork is built round it, which extends from the protective to the upper deck. This breastwork is formed of ¾-in. steel plates, with a teak backing 7 in. thick, this being faced by 5 in. steel armor-plating. The accommodation for the officers is aft, the cabins being sufficiently roomy, and below these is accommodation for petty officers. The full complement for each ship is 252 officers and men.

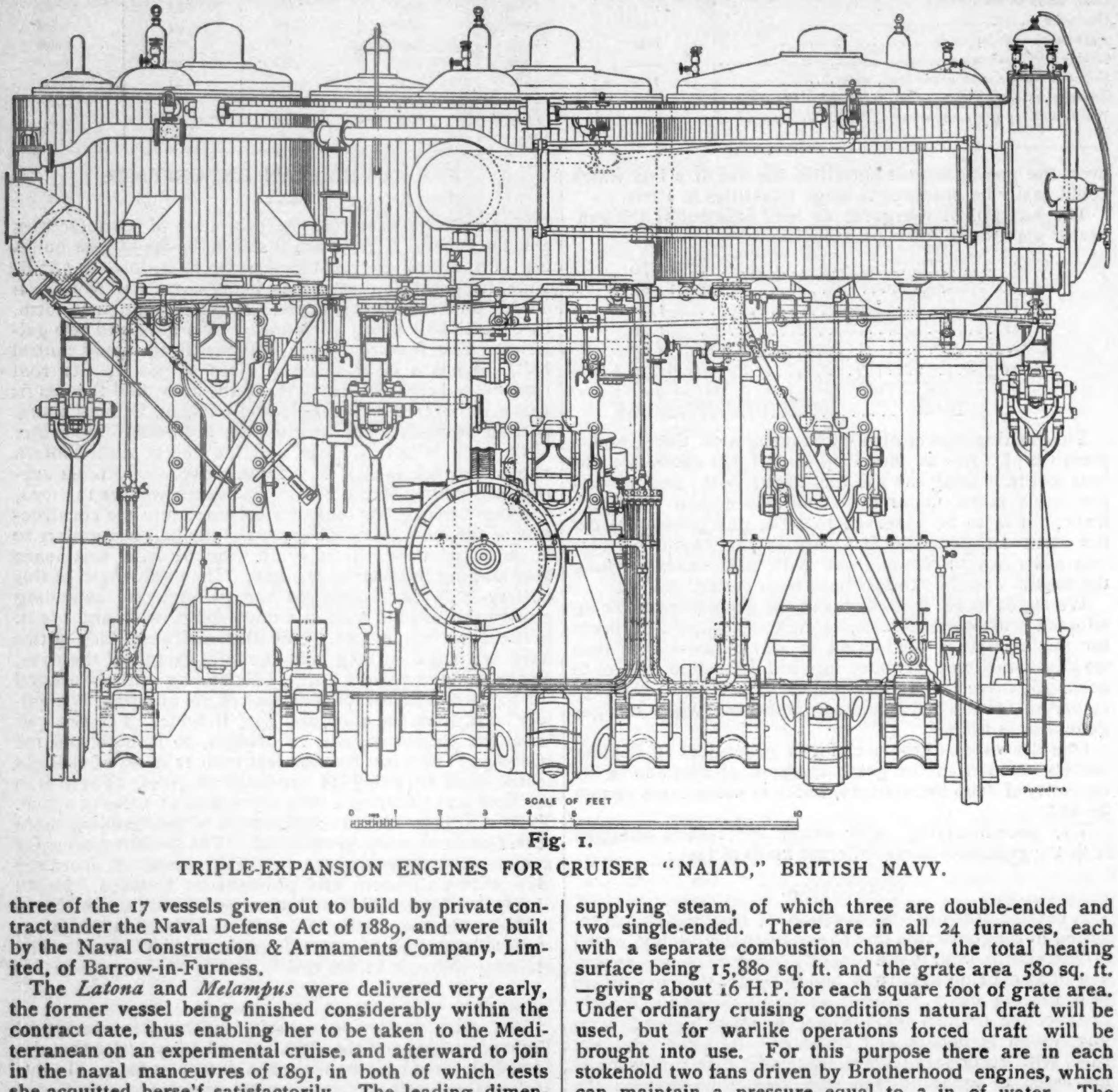


Fig. 1.

TRIPLE-EXPANSION ENGINES FOR CRUISER "NAIAD," BRITISH NAVY.

Placed in two separate stokeholds are five boilers for supplying steam, of which three are double-ended and two single-ended. There are in all 24 furnaces, each with a separate combustion chamber, the total heating surface being 15,880 sq. ft. and the grate area 580 sq. ft. —giving about 16 H.P. for each square foot of grate area. Under ordinary cruising conditions natural draft will be used, but for warlike operations forced draft will be brought into use. For this purpose there are in each stokehold two fans driven by Brotherhood engines, which can maintain a pressure equal to 3 in. of water. The propellers are of gun-metal, and are 13 ft. diameter, the blades being fitted to allow of variation of pitch. The shafts are of hollow steel, and are carried in steel brackets in the usual manner. There are two compound-wound dynamos, each capable of giving 300 ampères at 80 volts, coupled direct to steam-engines, and on these the entire artificial lighting of the ship depends.

The engines, which are built from designs by Mr. A. Blechynden, are of the type usually adopted in war vessels at the present day, being designed with the object of obtaining the maximum of strength from a given weight of material. They are of the triple-expansion type, with cylinders 33½ in., 49 in., and 74 in. diameter, by 39 in. stroke, and are required by contract to develop 7,000 H.P. with the boilers worked at an air pressure of 0.5 in. of water, and 9,000 H.P. with an air pressure of 1.25 in., the

revolutions at the latter power being 140, and the boiler pressure 155 lbs. per square inch. There are two engines, each driving one screw.

On the trials, which in the cases of all the three ships were carried out at Portsmouth, these powers were exceeded, in all cases everything working in a uniformly satisfactory manner, so that no hitch of any kind in the machinery caused loss or delay in a single trial.

On the eight hours' steam trial with natural draft the engines of the *Naiad* gave the following averages: Steam-

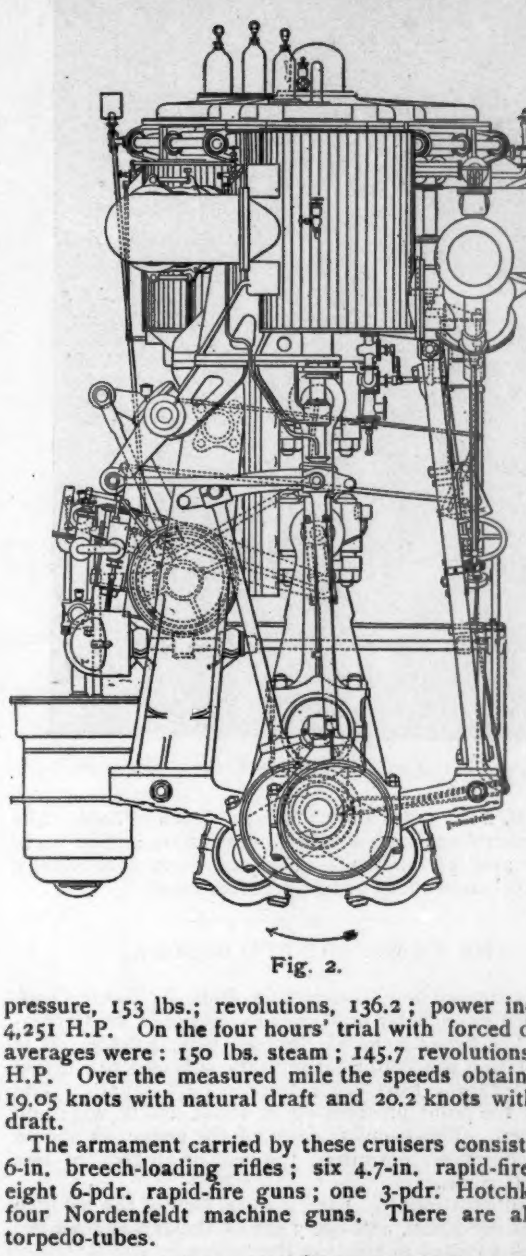


Fig. 2.

pressure, 153 lbs.; revolutions, 136.2; power indicated, 4,251 H.P. On the four hours' trial with forced draft the averages were: 150 lbs. steam; 145.7 revolutions; 9,250 H.P. Over the measured mile the speeds obtained were 19.05 knots with natural draft and 20.2 knots with forced draft.

The armament carried by these cruisers consists of two 6-in. breech-loading rifles; six 4.7-in. rapid-fire guns; eight 6-pdr. rapid-fire guns; one 3-pdr. Hotchkiss and four Nordenfeldt machine guns. There are also four torpedo-tubes.

THE SAULT STE. MARIE CANAL TRAFFIC.

THE comparative statement of the business of the Sault Ste. Marie Canal for the season is as follows:

	1891.	1890.	Change.
Vessels passed through	10,191	10,557	Dec. 366
No. of lockages	4,981	4,970	Inc. 11
No. of passengers	26,190	24,856	Inc. 1,334
Tons of freight	8,888,759	9,041,213	Dec. 152,454

Of the number of vessels 7,339 were steamers, 2,405 sailing vessels and 447 rafts and other unregistered craft.

Iron ore showed a decrease in 1891 of 1,012,280 tons, or 50 per cent., and the decrease was entirely from this cause. The course of business of the season is explained in the following extract from the report of General O. M. Poe, the engineer in charge of the canal:

The canal opened for navigation, April 27, 1891, and closed December 7. The season was, therefore, 225 days long, or three days shorter than in 1890. The average number of vessels passing per day for the whole season was 45.3, and for the months of June, July, August and September, the average was 54.6. The size of the vessels continues to increase, as is shown in the following statistics:

In 1887 the average registered tonnage per vessel was 626.3 tons
" 1888 " " " " " " " 701.5 "
" 1889 " " " " " " " 790.5 "
" 1890 " " " " " " " 833.8 "
" 1891 " " " " " " " 862.1 "

The total registered tonnage for the season falls 53,750 tons short of that for 1890, and the freight tonnage was 152,454 tons less. The following discussion of the appended statistics may not be inappropriate:

For the whole period since 1881, the iron ore carried through the canal has been 47 per cent. of the total freight, and in 1889 and 1890 it was more than 50 per cent.; therefore the freight may be divided into two nearly equal parts, one of which was the iron ore, the remainder being the aggregate of all other freights. The percentage of increase since 1881 falls between 12 and 39 each year, the average being 22. During 1890 the freight, other than iron ore, amounted to 4,266,445 tons, and for 1891, 5,328,548 tons. This shows an increase of 25 per cent. in the freight of 1891—other than iron ore—over 1890; or a little more than the average increase for the preceding ten years. Hence the decrease in iron ore freight alone is sufficient to explain why the business of 1891 did not show the usual increase. There were other causes, however, which materially affected the volume of the season's business, and they will be referred to later. The falling off in iron ore freight was predicted with certainty a year ago. It was due to causes so wide-spread and long-continued that a discussion here could hardly be made complete and satisfactory.

The freight of wheat and wheat products was abnormally large. Excluding iron ore and wheat in 1890, the remaining tonnage was 3,725,866 tons. The corresponding freight for 1891 was 4,340,660 tons. Hence the increase in freight, exclusive of iron ore, was 8 per cent., which indicates quite a falling off from the average rate of 22 per cent. for the last ten years, and shows that if the wheat crop of the northwest had not been unusually good this season there would have been a slight decrease in the volume of freight other than iron ore.

A further reason is found in the fact that the average stage of water in the lakes was lower than for many years past, so that the larger vessels were unable to take full cargoes. The traffic of the season was also light at the beginning, many ship-owners holding their vessels back in the hope of improving rates. The falling off in the iron ore traffic, however, remains the principal event of the season.

All things considered, the large amount of business actually done is a remarkable fact, and shows the great and increasing importance of the lake route in the transportation system of the country.

THE UNITED STATES NAVY.

SOME comparisons have been made between the new cruiser *New York* and the English cruiser *Blake*, which is a vessel of very much the same class. The *Blake* has some 900 tons more displacement than the *New York*, but her armament differs considerably from that of the American cruiser. The main battery consists of two 9.2-in. guns and ten 6-in. rapid-fire guns; the secondary battery includes sixteen 3-pdr. rapid-fire and seven machine guns, and she has four 14-in. torpedo tubes. The *New York* will have six 8-in. guns and twelve 4-in. rapid-fire guns in her main battery; eight 6-pdr. and four 1-pdr. rapid-fire and four machine guns in the secondary battery and six 18-in. torpedo-tubes.

The total weight of the *Blake's* fire is 1,808 lbs.; the total weight of her broadside fire 1,284 lbs., and of her fire ahead or astern 604 lbs. The *New York* will be able

to discharge 1,948 lbs. at a single round, of which 1,474 lbs. can be concentrated on a broadside fire and 1,156 lbs. ahead or astern, thus giving her a considerable advantage in weight of metal. The 9.2-in. guns of the *Blake* carry a projectile of 380 lbs., while the 8-in. shot weighs only 250 lbs.; but the higher velocity obtained from the American guns will give the shot almost equal penetration, and the 8-in. gun has the advantage in ease of handling and quickness of fire. The English 9.2-in. gun has not heretofore secured the best record for accuracy, and the 8-in. guns promise much better results. If the *New York* attains the promised speed she will be well able to stand a comparison with the English cruiser.

THE CERVEYRETTE BRIDGE, HAUTES-ALPES, FRANCE.

THE monitor *Miantonomoh* has been testing her new guns in the vicinity of Gardner's Island, at the eastern end of Long Island Sound. A number of charges have been fired from these guns with full charges and with lighter charges, and the results have been very satisfactory. The working of the turrets is also stated to have been excellent.

THE first of the 12-in. guns for the coast-defense ship *Monterey* has been sent to San Francisco. The gun was shipped by rail, mounted on a car built especially for the purpose and owned by the Pennsylvania Railroad Company. This car has an iron frame, and is carried on 16 wheels, arranged in four four-wheeled trucks.

The second 12-in. gun and the two 10-in. guns for the *Monterey* will follow as soon as possible, and all will be in San Francisco by the time the ship is ready for them. These first large caliber guns were made at the Washington gun-shop, the forgings having been bought in England. Since the first lot, however, all the forgings have been made in this country.

THE steamers *Venezuela*, of the Red D Line, and the *Newport*, of the Pacific Mail Line, have been inspected under the new law to ascertain their speed and other qualifications for postal service, and also to serve as cruisers in time of war. It is understood that both vessels were approved in the latter capacity, the inspectors reporting that they are of sufficient strength to carry batteries of heavy rapid-fire guns, and are otherwise adapted for cruising. Both vessels made the same speed on their trial trips —14.8 knots an hour. Both are iron screw steamers; the *Venezuela* was built at the Cramp yards in Philadelphia, and has triple-expansion engines. The *Newport* was built at the Roach yards at Chester, Pa., and is 306 ft. long, 38 ft. 2 in. beam and 23 ft. 9 in. depth of hold. She has compound engines, with cylinders 48 in. and 90 in. in diameter and 54 in. stroke. She can carry coal enough for 15 days' continuous cruising at full speed.

THE CERVEYRETTE BRIDGE.

THE accompanying illustrations, from *Le Génie Civil*, show a bridge recently built over the gorge of the Cerveyrette, in the department of Hautes-Alpes, France. It is on a mountain road built for military purposes to connect two frontier forts, Fort des Tetes and Fort Bayard. The ravine at the point of crossing is about 250 ft. wide and 280 ft. deep. The peculiar form of the gorge, as shown in fig. 2, however, permitted the use of an arch of less than 250 ft. span.

In the illustrations fig. 1 is a general view of the bridge; fig. 2 is an elevation, and fig. 3 shows the arrangement of false-work adopted in erecting the bridge.

The conditions required were that the bridge should have a total width of 13.12 ft., including a roadway of 8.20 ft., and two sidewalks of 2.46 ft. each; that the roadway should be macadamized, and that the structure should be proportioned for a rolling load of 62 lbs. per square foot, or of a train of loaded wagons weighing six tons per axle.

The plan adopted has an arch of parabolic form, having a span of 172.2 ft. and a rise of 37.7 ft. The arch is composed of two riveted trusses resting on masonry abutments on either side; these trusses are 6.5 ft. deep at the abutments and 2.5 ft. at the center. The trusses are inclined toward each other, being 19.68 ft. apart at the abutments and 11.81 ft. at the crown of the arch. The roadway is supported by vertical struts which are carried on the arch; a few of them on either side are beyond the arch and rest

on foundations made in the rock. These uprights are spaced 12.3 ft. apart. The trusses of the arch are thoroughly braced by a system of cross-bracing. They rest at the ends on cast-iron shoes secured to the masonry. The total weight of the bridge is 264,480 lbs.

Very little masonry was required, as the rocky sides of

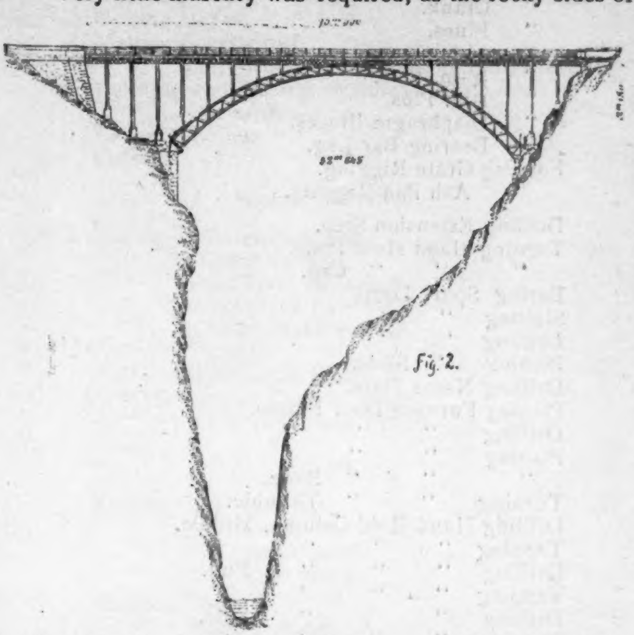


Fig. 2.

the gorge furnished foundations everywhere, only requiring work enough to make level beds for the abutments and supports.

In erecting the bridge advantage was taken of the peculiar section of the gorge to erect scaffolding, as shown

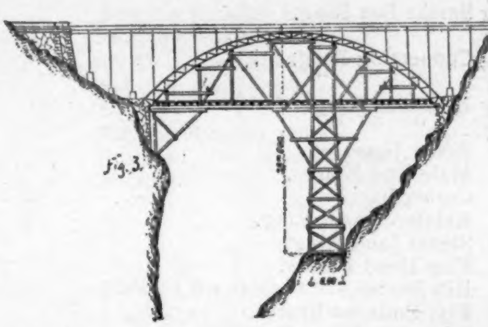


Fig. 3.

Fig. 4.

in fig. 3. This served to support a timber false-work or temporary bridge thrown across the ravine, which was kept in place until the arch was completed.

The design of the bridge was made by M. Comm. Baldy; it was built by Patiaud & Lagarde, of Lyons, as contractors.

A RAILROAD SCHOOL.

A RAILROAD department has been added to the Swiss Technical School at Bienne, its maintenance being provided for jointly by the Ministry of Railroads of the Swiss Government and the Jura-Simplon Railroad Company. Other companies, it is expected, will join in later. The school is divided into two branches, and its object is to train young men for railroad service. The first branch will prepare those who expect to work as trainmen, station employés, section foremen, and in other simpler grades, while the second is for those who aspire to the higher positions as chief of more important stations—master mechanics and other officers in the general management—and the courses are arranged so as to give the lower instruction or more extended course. Those who desire to prepare themselves for positions in the mechanical department are required to serve an apprenticeship in some well-known machine shop or as fireman on a locomotive. Provision is made by which employés already engaged on a railroad can take a short course of one or two terms. The second term of this school began in August of the present year with 42 pupils, and in addition arrangements had been made by which a number of employés were to take the short course during the winter. In addition to all the facilities of the technical school, the teachers and pupils will be enabled to use the extensive repair shops of the Jura-Simplon Company at Bienne and of the Jura-Berne-Lucerne Company at Yverdon.

CLASSIFICATION OF PIECE-WORK ON LOCOMOTIVES.

(*Continued from page 25.*)

WE continue below the classification of locomotive piece-work, which was begun in the January number. As then explained, this classification is that which has been adopted for the shops of a leading railroad, in which new construction as well as repair work is done, and is for an eight-wheel passenger locomotive. In use it is made out in table form, the columns of the table containing the name of the piece and the work and the price paid, per piece, pair, or set. It has not been thought necessary to use this form here, the object being to show the division and classification of the work only:

DRIVING SPRING AND RIGGING.

Forging Equalizer Stand.
" " Beam.
" Front Spring Hanger.
" Back " "
" Intermediate Spring Hanger.
" Spring Plate.
" Large Spring Keys.
" Small " "
" Spring Hanger Bolt.
Drawing Spring Plate.
Forging Band.
Setting Plate.
Banding Spring.

Drilling Equalizer Stand.
Planing " "
Slotting "
Milling "
Drilling Spring Hanger.
Chipping " "
Planing " Key.
Turning " Hanger Bolt.

DRIVING WHEELS AND AXLES.

Forging Steel Axles.
" " Crank Pins.
" Crank Pin Washer.
" Hexagon Nuts, for Crank Pin.
" Crank Pin Nut.
" Steel Key.

Molding Wheel Center.
" Driving Box.
" " " Oil Cellar.
" Axle Collar.

Planing Driving Box.
Boring " "
Drilling " "
Slotting " "
Fitting " "
Boring Axle Collar.
Turning " "
" Steel Axle.
Milling " "
Turning Crank Pin.
Milling " "
Turning " " Washer.
" " " Nut.
Boring Wheel Center.
Turning " "
Quartering " "

Boring for Crank Pin.
Pressing Wheel Center on Axle.
Boring Steel Tire.
Turning " "
Balancing Wheel Center.
Driving on Tire.
Putting Driving Wheels under Engine.

STEEL MAIN RODS.

Blocking Main and Side Rods (at furnace).
Trimming " " " " (at forge).
Forging " Rod Strap.
" Side " "
" Safety Yoke.
" Main Rod Keys.
" " " Gibbs.
Molding " " Brasses.
" Side " Bushings.
" Rod Oil Cup.
Planing Main Rod Brasses.
Boring " " "
Turning Side " Bushings.
" Rod Oil Cups.
Planing Main Rods.
Milling Keyways.
Facing Rods.
Planing Main Strap.
Slotting " "
Boring Brasses.
Grinding and Buffing.
Turning Steel Set Screws.
" Main Rod Strap Bolt.
Tapping " " " " Nuts.
Turning Oil Cup.
" " Cellar Bolt.
Fitting up Oil Cellar.
" " Rods.
Filing Brasses and Putting on Engine.

STEEL SIDE RODS.

Planing Side Rods.
Milling " "
Boring " "
Turning and Boring Bushing.
" Oil Cup Bolt.
Fitting up Rods.
Filing Brasses and Putting on Engine.

BOILER CASTINGS.

Molding Extension Side Step.
" " Hand Hold Plates.
" " " " Caps.
" " Spark Drop.
" " " Slide.
" Name Plate.
" Furnace Door Frame.
" " " R. & L.
" " " Slide.
" " " Thimble.
" Hand Rail Column, Middle.
" " " " End.
" " " " Side.
" " " Ornament.
" " " Socket.
" Grate Bearing Bar.
" Drop Grate.
" Dead "
" Grate Bars.
" Bearings for Ash Pan Slide.

BOILER FORGINGS.

Forging Mud Ring.
" Smoke Box Ring.
" Connecting Ring.
" Extension Ring.
" Jaws for Braces.
" Male Ends for Braces.
" Crown Bars.
" Reinforcement Ring.
" Steam Joint Ring.

Forging Flue Head Braces.
" Rib Braces.
" Flat Ends for Braces.
" Links for Crown Bars.
" Door Bar.
Crown Bar Bolts.
" Crank.
" Flues.
" ⅞-in. Pins.
" ¾-in. Pins.
" 1-in. Pins.
" Diaphragm Braces.
" Bearing Bar Lug.
Forging Grate Rigging.
" Ash Pan Rigging.
Drilling Extension Step.
Turning Hand Hold Plate.
" " " Cap.
Boring Spark Drop.
Slotting " "
Drilling " "
Planing " Slide.
Drilling Name Plate.
Planing Furnace Door Frame.
Drilling " " "
Planing " "
" " " Slide.
Turning " " Thimble.
Drilling Hand Hold Column, Middle.
Tapping " " " "
Drilling " " " End.
Tapping " " " "
Drilling " " " Side.
Tapping " " " "
Turning " " Ornament.
Boring " " Socket.
Turning Bearing Bar Lug.
Planing Mud Ring.
Drilling " "
Turning Smoke Box Ring.
Drilling " " "
Turning Connecting Ring.
Drilling " "
Turning Extension Ring.
Drilling " "
" Brace Jaws.
" Male End Braces.
" Crown Bars.
" Reinforcement Ring.
" Steam Joint Ring.
" Flue Head Braces.
" Rib Braces.
" Flat Ends for Braces.
" Links for Crown Bars.
" Door Bar.
" Crown Bar Bolts.
" Crank.
" Diaphragm Braces.
" Grate Rigging.
" Ash Pan Rigging.

ENGINE BOILER.

Laying off Boiler.
Flanging "
Drilling "
Punching "
Planing "
Bracing "
Fitting up "
Steam Riveting Boiler.
Hand " "
Caulking "
Blacksmithing "
Putting in Stay Bolts.
Driving " "
Making Boiler Bracket.
Drilling Flue Holes.
Putting in Flues.
" " Fire Brick.
" " Combustible Tubes.

Fitting and Putting in Grate and Bearing Bars.
" " " up Arch over Axle.
Making Apron.
" Foot-board Plates.
Building Ash-pan.
Applying " "
Testing Boiler.
Making Spark-drop.
" and Putting in Diaphragm and Netting.
Building and Putting on Smoke Stack.
" Air-tank.
Lagging Boiler.
Casing "

BOILER FITTINGS.

Fitting on Extension Step.
" in Spark Casting.
" Initial Plate on Boiler.
" Smoke-stack Base on Boiler.
" up Short Hand-railing.
" " Long " "
" Mud-plug in Boiler.
" Blow-off Cock in Boiler.
" up Furnace Door Frame.

PILOT.

Forging Pilot Braces.
" " Band.
" " Draw-head.
" " Heel-brace.
Molding Steps.
" Nose Casting.
Making Pilot.
Putting on Pilot Band.
" Pilot on Engine.

BUMPER.

Forging Bumper Braces.
Molding Bumper Knee.
" Flag Stand.
Planing Bumper Knee.
Drilling " "
Making Bumper.
Putting " on Engine.
Making " Deck Plate.
" " Step Braces.

FRONT.

Molding Smoke-box Front.
" " " Door.
" " " Knob.
" Number Plate.
" Head-lamp Bracket.
" " " Column.
Turning Smoke-box Front.
" " " Door.
Drilling Hinges on Front and Door.
Fitting Door in Front.
" up Front and Door.
" " Lamp Bracket.
" " Number Plate.
" " Hand Railing.
" " Signal Lamp Bracket.

STEAM-PIPES.

Molding Steam-pipes, Right and Left.
" Cross-pipe.
" Exhaust Base.
" " Nozzle.
" Steam-pipe Joint.
Slotting Steam-pipes.
Facing off Cross-pipe.
Drilling and Balling Steam-pipe.
Turning Steam-pipe Joint.
Grinding " " "
Fitting up Steam-pipes.

THROTTLE AND DRY-PIPE.

Molding Upright Pipe.
" Throttle Chamber.
" " Valve.
" Stuffing-box.
" Elbow for Dry-pipe.
" Sleeve " " "
Turning Throttle Upright Pipe.
" Dry-pipe End, Large.
" " " " Small.
" Throttle Lever End.
" " Stuffing-box.
" " " " Stem.
Boring " Chamber Pipe.
Riveting Dry-pipe Casting.
Fitting up Throttle and Dry-pipe.

MANIFOLD.

Molding Manifold.
Turning "
Drilling "
Fitting "
" " in Boiler.

SAND-BOX.

Molding Sand-box Base.
" " " Casing Cover.
" " " Lid.
" " " Valve.
" " " " Crank.
" " " Link.
Turning " " Base.
" " " Casing Cover.
" " " Lid.
Filing " Rod Handles.
Fitting up Sand-box, Complete.

BELL.

Forging Bell Hanger.
" " Clapper.
Molding Bell.
" " Stand.
" " Yoke.
" " Rope Crank.
Turning Bell.
" " Clapper.
" " Yoke.
Boring " "
Slotting " Stand.
Boring " "
Drilling " "
Fitting up " and Bell.

DOME.

Molding Dome Ring.
" " Casing Base.
" " " Cover.
" " Cap.
Turning " "
" " Ring.
" " Casing Base.
" " " Cover.
Drilling " Cap.
Making and Putting on Joint.
Fitting up Dome Base, Cover and Cap.

SAFETY-VALVE.

Forging Safety-valve Lever.
" " " Fulcrum.
" " " Stand.
Molding " "
Turning " "
Grinding " " Joint.
Fitting up Safety-valve.

POP-VALVE.

Molding Pop-valve.
" " Bridge.
Forging Pop-valve, Stem.
Turning " "
" " " Stem.
" " " Seat.
Fitting up Pop-valve.

WHISTLE.

Forging Whistle Lever.
" " Plug.
Molding Whistle.
" " Handle.
" " Shaft Stand.
" " " Crank.
" " Bell "

Fitting Cab Bell Cord Ring Pulley.
" " " " Hook.
" " " " Bushing.
Covering Cab Roof with Galvanized Iron.
Fitting " on Boiler.

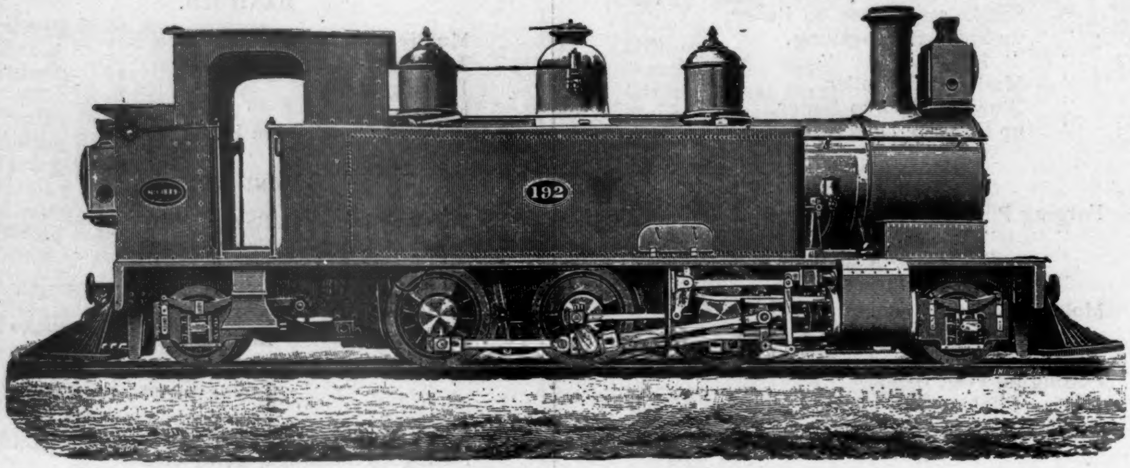
This classification will be concluded in the next number.

(TO BE CONTINUED.)

NEW ZEALAND ROLLING STOCK.

(From *Industries*.)

THE accompanying engravings represent a ten-wheeled tank locomotive and a first-class saloon car constructed for the New Zealand Government Railroads. The engine shown was constructed at the railroad workshops, Christ-



LOCOMOTIVE FOR NEW ZEALAND GOVERNMENT RAILROADS.

Turning Whistle.
" " Plug.
" " Shaft.
Fitting up Whistle.

RUNNING BOARDS.

Forging Running Board Brace.
Dressing " "
Sizing " "
Making " "
" " " Strip, or Strap.
Putting on Running Board " " "
Drilling Running Board Braces.
Fitting " " "
Putting " " on Engine.

CAB.

Forging Cab Brace.
Molding " Bracket, Right and Left.
" " Saddle.
" " Gong.
Dressing Cab.
Cutting and Sizing Cab.
Tenoning Cab.
Mortising "
Boring "
Working Moldings.
Band Sawing Cab.
Fitting up "
Making Cab Plates. "
Drilling and Fitting Cab Bracket.
" " " Front Cab Bracket.
Fitting Cab Gong.
" " Door Hooks.
Bronzing Cab Door Hooks.
Fitting " " Bolts.
" " " Long Slide Hooks.
" " " Lifts.

church, New Zealand, from designs made by Mr. T. F. Rotherham, the Locomotive Superintendent, to whom we are indebted for photographs and the particulars we now publish. The engine was designed for the heavy gradient traffic on the Wellington system, and is of a type not hitherto used in the colony. The leading particulars are: Gauge, 3 ft. 6 in.; weight, with tanks and bunkers full, 36 tons, distributed as follows: 5¼ tons on each leading and trailing truck axle and 8½ tons on each coupled axle. The boiler is of the Belpaire pattern, 3 ft. 6 in. diameter, of Lowmoor iron $\frac{7}{16}$ in. thick, and capable of allowing a working pressure of 160 lbs. per square inch. The engine has outside cylinders, 14 in. diameter and 20 in. stroke, fitted with Walschaert valve-gear. Owing to the heavy gradients on various sections of the Wellington system, the engine has six wheels coupled, and to easily get round the sharp curves a truck has been provided at each end. We may mention that it has already been running for upward of 18 months on gradients of 1 in 33 with curves of five chains radius, and with a working load, exclusive of its own weight, of 125 tons.

The saloon car illustrated has been designed by Mr. T. F. Rotherham, and the design is based on an idea furnished by Mr. J. P. Maxwell, one of the Railroad Commissioners, to meet the requirements of the service and to render long journeys less irksome. These cars are 39 ft. 6 in. long, carried on two four-wheeled trucks, the centers of which are 26 ft. 6 in. apart; the trucks have wheel-bases of 4 ft. 10 in. The cars are divided into four compartments, one general, two small first-class, and one fitted with lavatory, etc., while along one side, for rather more than half the length of the body, a gallery extends, formed by the difference in width between the general and smaller apartments. This gallery, which is accessible from all apartments, is fenced as shown, for the safety of the passengers, by an ornamental iron railing. The general compartment is intended to carry 20 persons, and the small compartments, one of which is intended for smokers, are each capable of accommodating eight pas-

sengers. The cars are painted Indian red, picked out with black, and fine-lined with yellow, and each weigh 12 tons.

PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 31.)

It will be seen from the foregoing statements of what has been accomplished with beating wings, that the principal questions are those of motive power and of proportion of surfaces to weight, and the reader will probably first inquire as to what is really the power developed by birds in their flight. The answer must unfortunately be, that it is not accurately known. A great many computations have been made, based upon more or less plausible assumptions, but none of these computations can be absolutely accepted as correctly based upon indisputably measured data.

This ceases to be surprising when we consider that there is no creature so willful, so swift, and so easily affrighted as the bird, and that once in the air, he will not lend himself to be measured experimentally. Mathematicians have, therefore, partly resorted to conjectures for their data. Thus Napier assumed that a swallow weighing 0.58 oz. must beat his wings 2,100 times per minute while going 33½ miles per hour, in order to progress and sustain his weight, and that it therefore expended $\frac{1}{13}$ of a horse power. In point of fact, the bird only beats about 360 times a minute, and is chiefly sustained by the vertical component of the air pressure on the under side of the wings and body, due to the speed, instead of by the direct blow of the wings downward, as supposed in the orthogonal theory already alluded to.

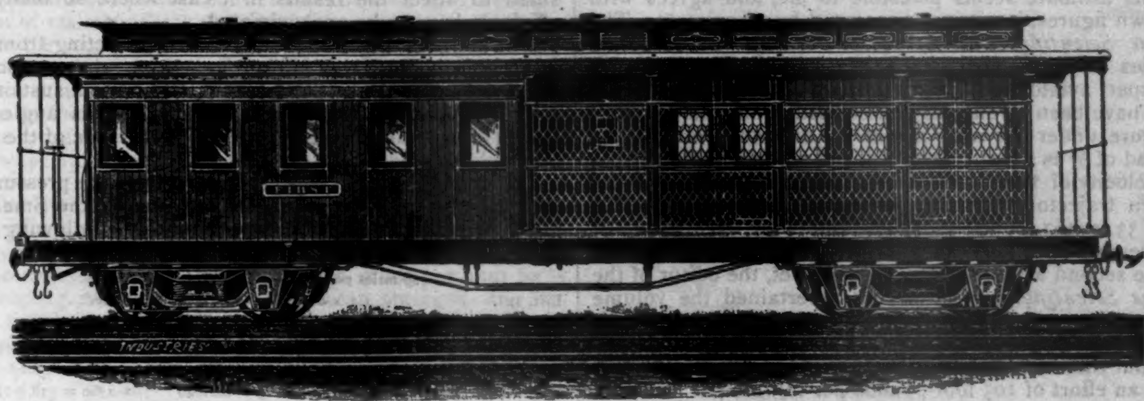
Other mathematicians, starting from the fact that a weight falls about 16 ft. during the first second, and in so dropping does work, have assumed that a b rd in horizontal flight, being then sustained, performs a certain fraction of this work. It is evident, however, that if the bird does not drop, the fraction assumed is purely arbitrary, and that such calculations must be quite worthless.

Experiments to measure directly the power expended have proved failures, and resort has been had to indirect measurements.

Thus Dr. W. Smyth, of Edinburgh, succeeded in measuring with a dynamometer the strain exerted by a 12-oz. pigeon while flexing its wings, when excited by a current of electricity, and found it capable of raising 120 lbs. one foot high in a minute, or at the rate of 160 foot-pounds per pound of bird. Professor Marey performed the same experiment on the buzzard and on the pigeon, and ascertained the contractile strength of their muscles to be 18.46 and 19.91 lbs. to the square inch respectively; * but as he was unable to measure satisfactorily the rapidity with which the muscles contracted, he did not calculate the foot-pounds.

Mr. Alexander, starting with the assumption that a 2-lb. pigeon makes 180 completed strokes per minute, each stroke with an amplitude of 1.5 ft. at the center of pressure, calculates the power exerted as being $2 \times 180 \times 1.5 = 540$ foot-pounds per minute, or at the rate of 270 foot-pounds per pound of bird. This is plausible; but the most satisfactory computations are those made by Pénaud from observations of the direct velocity of ascent of various birds. From these he concludes that the pigeon, for instance, expends for rising 579 foot-pounds per minute, and that the proportion of horse power to weight is as follows:

For the peacock,	one horse power for every	66 lbs.
" " pigeon,	" " " " "	57 "
" " sparrow,	" " " " "	48½ "
" " sea pie,	" " " " "	26 "



PASSENGER SALOON CAR, NEW ZEALAND RAILROADS.

This, however, is merely the work of elevation, such as would be performed upon a solid support, in addition to which the bird has to overcome the resistance of the air to his motion, and to derive support from this mobile fluid. Pénaud calculates that this additional work amounts to over 1,000 foot-pounds per minute, so that the total work done by the pigeon in rising to a perch 35 ft. above the ground amounts to 1,650 foot-pounds per minute, or 1 horse power for every 20 lbs. Moreover, it must be remembered that the pectoral muscles of birds, which constitute their motor, comprise but one-quarter to one-sixth of their total weight, so that in this particular case the relative weight of the motor is only about 5 lbs. per horse power for the force exerted in rising.

These are formidable figures, but they cease to be discouraging when we reflect that the effort of rising is evidently a maximum, and that birds seldom perform it in a nearly vertical direction except for short distances, and that the exertion is clearly so severe that the feat is usually performed only by the smaller birds, which, as previously explained, must possess greater energy in proportion to their weight than those exceeding a few ounces. Heavy birds can only rise at angles less than 45°, and even then they exert for a short time far more than their mean strength, the latter being, for all animals, only a fraction of the maximum possible effort. Thus man, who is usually estimated as capable of exerting 0.13 horse power for 10 hours, can develop 0.55 horse power for 2¼ minutes, and nearly a full horse power for 3 or 4 seconds; and it seems probable that similar proportions obtain for birds, the emergency effort being three or four times the average performance, and the possible maximum about twice as great as the emergency effort.

Pénaud states that the ring-dove dispenses in full flight 217 foot-pounds per minute; but he does not give figures for this, so that they can be checked. Goupil estimates the work done by a pigeon weighing 0.925 lbs. at 1,085 foot-pounds per minute in hovering and 119 foot-pounds per minute in flight; but the latter is arrived at by reasoning from analogy. It is evident that the power exerted in horizontal flight is much less than that required for rising or for hovering; but until a bird is taught to tow behind him some dynamometric arrangement at a regular rate of speed, and on a level course, it will be diffi-

* "Vol des oiseaux," page 92.

cult to settle exactly what are the feet-pounds expended in ordinary performance.

In 1889 Captain de Labouret, an expert in the solution of balistic problems, analyzed mathematically two series of photographs of a gull weighing 1.37 lbs., and just starting out in flight with 5 wing beats per second, as obtained by by Professor Marey with the chrono-photographic process. The calculations showed that the bird expended in this act an average of 3,152 foot-pounds per minute, or 2,303 foot-pounds per pound of his weight; and as Professor Marey shows that from his other observations of the reduced amplitude and rapidity of the wing beats, the same bird does only expend in full flight ⅐ of the effort required at starting, the conclusion may be drawn that the gull in full flight expends some 460 foot-pounds per minute for each pound of his weight.

This estimate seems plausible to me, and agrees with my own figures, but it is not accepted by all aviators. The *Revue Scientifique* of November 28, 1891, contains two articles disputing the conclusions—one by Mr. V. Tatin, an expert aviator, who claims that the accelerations of the bird have been erroneously calculated; that the center of pressure under the wing is ⅕ of the distance from its root instead of ⅔, as usually assumed, and who figures out from the velocity of this new center of pressure, and from the known trajectory that the bird in full flight only expends from 33 to 197 foot-pounds per minute for each pound of his weight.

The second article is by Mr. C. Richet, the editor of the *Revue Scientifique*, who, having ascertained the volume of carbonic acid exhaled by a bird at rest, assumes, from experiments on other animals, that in full flight he will give out three times as much, and that the difference represents an effort of 105 foot-pounds per minute per pound of bird.

These two articles, being the most recent computations by earnest students of the subject, are here mentioned chiefly to illustrate how greatly aviators vary in estimates of the power expended, and how many elements have to be assumed in making such computations.

In the absence of direct measurements, and of positively satisfactory computation by others, of the feet-pounds expended in horizontal flight, I believe that an approximation may be obtained by analyzing and calculating the various elements which combine to make up the aggregate of the resistance to forward motion in horizontal progression; and as this method promises to be useful in computing the power required by artificial flying machines, I venture to set it out at some length, applying it to the domestic pigeon as being more convenient to compare with the results of the calculations of others. For this purpose two dead pigeons were selected, weighing as near as practicable 1 lb. each, and their dimensions were accurately measured as follows:

CROSS SECTION AND HORIZONTAL PROJECTION OF PIGEONS.

	Pigeon No. 1.	Pigeon No. 2.
Largest cross section of body..............	4.9 sq. in.	5.3 sq. in.
" " " edge of wings....	5.02 " "	4.88 " "
Weight of bird, freshly killed	1 lb.	0.969 lb.
Horizontal area of both spread wings	90.35 sq. in.	09.86 sq. in.
" " " body projected..........	22.49 " "	24.01 " "
" " " tail spread..........	19.72 " "	27.17 " "
	132.56 sq. in.	151.04 sq. in.

These dimensions all require the application of coefficients in calculating their action upon the air. Thus the wings are concave, and give a greater sustaining power per square foot than a flat plane; the body is convex, and affords less than a plane, while the tail is slightly concave, but partly ineffective from its position. Previous experiments have indicated that, in the aggregate, the supporting power is about 30 per cent. more than that of a flat plane of equal area, so that in the calculations which follow the supporting surfaces will be assumed at 1.3 sq. ft. to the pound instead of the 1 square foot to the pound which the average of the measurements seems to indicate.

It will be remembered that experiments with parachutes indicate a coefficient of resistance of 0.768 for the convex side and of 1.936 for the concave side, as compared with the plane of greatest cross section.

The cross sectional area of the body is assumed at 5 square inches or 0.03472 of a square foot and to this a coefficient is applied of one-twentieth of a flat plane, or 0.05, in consequence of its elongated, fusiform shape. This agrees well with experiments on the hulls of ships of "fair" shape.

The cross sectional area of the wings is also taken at 5 square inches, or 0.03472 of a square foot; but the coefficient here assumed is about one-seventh, or 0.15, in consequence of its ogival shape, or rather something like only half of a Gothic arch.

The friction of the air is omitted, as being entirely too small to affect the results in a case where so many coefficients have to be approximated.

The angle of flight is ascertained by selecting from the table previously given of air reactions, the coefficient which will give the nearest approximation to a sustaining "lift" to support the weight, and from this angle the "drift" is obtained to calculate the resistance of the surface.

The velocity V is in feet per minute, and the pressure P on a plaue at right angles to the current by the Smeaton formula is in pounds per square foot. The following are the calculations:

20 miles per hour—$V = 1760$ ft. $P = 2$ lbs.

		Resistance.	Power.
Lift, 12°,	1.3 × 2 × 0.39 =	1.014 lbs. sustained.	
Drift, 12°,	1.3 × 2 × 0.0828 =	0.21520 lb.	× 1760 = 378.7 ft. lbs.
Body resistance,	0.03472 × 2 × 0.05 =	0.00347 "	× 1760 = 6.1 "
Edge wings,	0.03472 × 2 × 0.15 =	0.01040 "	× 1760 = 18.3 "
		0.22907 lb.	403.1 ft. lbs.

30 miles per hour—$V = 2640$ ft. $P = 4.5$ lbs.

		Resistance.	Power.
Lift, 5°,	1.3 × 4.5 × 0.173 =	1.012 lbs. sustained.	
Drift, 5°,	1.3 × 4.5 × 0.0152 =	0.08892 lb.	× 2640 = 234.7 ft. lbs.
Body resistance,	0.03472 × 4.5 × 0.05 =	0.00781 "	× 2640 = 20 6 "
Edge wings,	0.03472 × 4.5 × 0.15 =	0.02343 "	× 2640 = 61.9 "
		0.12016 lb.	317.2 ft. lbs.

40 miles per hour—$V = 3520$ ft. $P = 8$ lbs.

		Resistance.	Power.
Lift, 3°,	1.3 × 8 × 0.104 =		1.082 lbs. sustained.
Drift, 3°,	1.3 × 8 × 0.00543 =	0.05647 lb.	× 3520 = 198.7 ft. lbs.
Body resistance,	0.03472 × 8 × 0.05 =	0.01389 "	× 3520 = 48.9 "
Edge wings,	0.03472 × 8 × 0.15 =	0.04166 "	× 3520 = 146.6 "
		0.11202 lb.	394.2 ft. lbs.

50 miles per hour—$V = 4400$ ft. $P = 12.5$ lbs.

		Resistance.	Power.
Lift, 2°,	1.3 × 12.5 × 0.07 =		1.137 lbs. sustained.
Drift, 2°,	1.3 × 12.5 × 0.00244 =	0.03965 lb.	× 4400 = 174.5 ft. lbs.
Body resistance,	0.03472 × 12.5 × 0.05 =	0.02170 "	× 4400 = 95.5 "
Edge wings,	0.03472 × 12.5 × 0.15 =	0.06510 "	× 4400 = 286.5 "
		0.12645 lb.	556.5 ft. lbs.

60 miles per hour—$V = 5280$ ft. $P = 18$ lbs.

		Resistance.	Power.
Lift, 1½°,	1.3 × 18 × 0.052 =		1.217 lbs. sustained.
Drift, 1½°,	1.3 × 18 × 0 00136 =	0.0318 lb.	× 5280 = 167.9 ft. lbs.
Body resistance,	0.03472 × 18 × 0.05 =	0.0312 "	× 5280 = 164.7 "
Edge wings,	0.03472 × 18 × 0.15 =	0.0937 "	× 5280 = 494.7 "
		0.1567 lb.	827.3 ft. lbs.

These figures are probably somewhat in excess of the real facts in consequence of the adoption of slightly excessive coefficients for the resistance of the body and wing edges, which coefficients in full flight may be as much as one-third less than those which have been estimated.

It will be noticed that, as the velocity and the consequent air pressures increase, the angle of incidence required to obtain a sustaining reaction or "lift" diminishes, and so does, therefore, the "drift" or horizontal component of the normal pressure, while the "hull resistance," consisting of that of the body and edges of the wings, is at the same time increasing. There will therefore be some angle at which these various factors will so

combine as to give a minimum of resistance, and this is probably for most birds at an angle of about 3°, which in the case of our calculated pigeon requires a speed of 40 miles per hour in order to sustain the weight.

This angle of minimum resistance depends upon the relative proportions of the bird—*i.e.*, upon the ratio between his surface in square feet per pound of weight, and the cross section of his body and wings, as well as their coefficient of resistance; and so, while the angle may not vary greatly, it needs to be ascertained for each case. Mr. Drzewiecki has calculated that for an aeroplane exposing a cross sectional area of one per cent of its sustaining area (instead of the seven per cent which the measurements show for the pigeon), the angle of minimum resistance would be 1° 50′ 45″, and that it would be the same for all velocities. It does not follow, however, that the minimum of power required will coincide with the minimum of resistance, for the latter increases as the square, while the power grows as the cube of the speed. The calculations, therefore, show that the minimum of resistance occurs at 40 miles per hour, while the minimum of work done in foot-pounds is found at 30 miles per hour, and these two favorable speeds are about those observed from railway trains, as habitually practised by the domestic pigeon.

The estimates of the feet-pounds per minute indicate that the bird finds it less fatiguing to fly at 30 miles per hour than at 20; that his exertions are not much greater at 40 miles per hour, but that at 50 miles per hour he is expending rather more than his mean strength—the latter being probably about 425 foot-pounds per minute, nearly an average of the first four calculations, or about one-quarter of the maximum work done in rising, as estimated by Pénaud.

A flight of 60 miles within the hour is probably a severe exertion for the domestic pigeon, while the finer lines and greater endurance of the carrier pigeon enable him to maintain this speed for hours at a time; but there is reason to believe that this must be nearly the limit of his strength, and that homing birds who have made records of 70 and 75 miles per hour were materially aided by the wind.

The calculations therefore appear plausible, and to agree fairly well with the estimates arrived at with different methods by others. They indicate that if a flying machine can be built to be as efficient as the domestic pigeon, its motor should develop one horse power for each 18 lbs. of its weight, provided it can give out momentarily about four times its normal energy, or that special devices, such as that of running down an incline or utilizing the wind, or some other contrivance are adopted to give it a start and to enable it to rise upon the air.

The next question which the reader will probably want to ask, is as to the amount of supporting surfaces possessed by birds in proportion to their weight. Upon this point a good deal of information has been published; and in 1865 Mr. De Lucy greatly cheered aviators by publishing a paper in which he showed that the wing areas of flying animals diminish as the weight increases, from some 49 square feet to the pound in the gnat to 0.44 square feet to the pound in the Australian crane; and from which tables he inferred the broad law that the greater the weight and size of the volant animal, the less relative wing surface it required.

As thus stated, the assertion is misleading. For inasmuch as the supporting surfaces will increase as the square, and the weight will grow as the cube of the homologous dimensions, it was to be expected that wing surfaces would not increase in the same ratio as the weight if the strength of the parts remained the same; and in 1869 Hartings published some tables of birds, in which he compared the square root of the wing surface with the cube root of the weight, and showed that their ratio became what he considered a somewhat irregular constant. Subsequent measurements and tables by Professor Marey have shown that this statement of Hartings is also slightly misleading, inasmuch as the so-called constant varies from 1.69 to 3.13, so that no broad law can be laid down as to any fixed relation between the surfaces and weight of birds of various sizes. The fact seems to be that while their structures are governed by the laws which limit the strength of materials (bones, muscles, feathers, etc.), yet there are differences in the resulting stresses, and in the consequent efficiency of the birds themselves, who are thereby led to adopt slightly different modes of flight; and in 1884 Müllenhoff published an able paper, in which he divided flying animals into six series, in accordance with the ratio between their weight and their wing surface, as well as their methods of flight. As the tables of De Lucy, Hartings,

TABLE OF SUPPORTING AREAS OF BIRDS.
MEASURED BY L. P. MOUILLARD.
COMPILED BY S. DRZEWIECKI.

Scientific Name.	Common Name.	Sq. Ft. per Lb.	Lbs. per Sq. Ft.	Corr'sp'ding speed for a plane at 3° Miles per hr
Nyctinomous ægypticus	Bat	7.64	0.131	15.9
Upupa epops	Peewit	3.62	0.276	23.1
Cotile rupestris	Swallow	3.62	0.276	23.1
Budytes flava	Wagtail	3.49	0.286	23.5
Galerita cristata I	Lark	3.18	0.315	24.6
Caprimulgus	Goatsucker	3.17	0.314	24.6
Galerita cristata II	Lark	3.06	0.327	25.1
Accipter nisus	Sparrow-hawk	3.00	0.333	25.3
Pteropus Geoffroyi	Bat	2.79	0.362	26.2
Coracias garrulus	Roller	2.76	0.363	26.5
Tringa canutus	Knot	2.64	0.380	27.0
Falco tinnunculus	Falcon	2.48	0.403	27.9
Passer domesticus I	Sparrow	2.42	0.414	28.2
Vanellus cristatus	Lapwing	2.40	0.417	28 3
Passer domesticus II	Sparrow	2.36	0.424	28.6
Cypselus apus	Martinet	2.35	0.426	28.6
Larus melanocephalus I.	Gull	2.35	0.426	28.6
Glareola torquata	Glareola	2.32	0.431	28.8
Larus melanocephalus II	Gull	2.30	0.435	28.9
Turtur ægypticus	Egyptian Dove.	2.27	0.441	29.2
Otus brachyotus	Owl	2.26	0.443	29.2
Strix flammea	"	2.26	0.443	29.2
Milvus ægypticus	Kite	2.19	0.457	29.7
Petrocincla cyanea	Blackbird	2.18	0.460	29.7
Alcedo hispada I	Kingfisher.	2.11	0.475	30.3
" " II	"	2.11	0.475	30.3
Buphus minutus	Crane	2.02	0.495	30.9
Scolopax gallinula I	Snipe	1.96	0.510	31.4
Ephialtes zorca	Scops	1.90	0.526	31.8
Alcedo hispida III	Kingfisher	1.87	0.535	32.1
Corvus ægypticus	Rook	1.74	0.575	33.3
Astur palumbarius	Goss-hawk	1.73	0.579	33.4
Ibis falcinellus	Ibis	1.66	0.603	34.1
Sturnus vulgaris	Starling	1.65	0.606	34.2
Scolopax capiensis	Snipe	1.65	0.606	34.2
Corvus corax	Raven	1.62	0.614	34.5
Scolopax gallinula II	Snipe	1 60	0.625	34.7
Philomachus pugnax	Water-fowl	1.48	0.634	36.1
Ardea nycticorax	Night Heron	1.43	0.700	36.7
Ciconia alba	Stork	1.40	0.715	37.1
Charadrius pluvialis	Plover	1.38	0.725	37.4
Columbia ægyptica I	Egyptian pigeon	1.37	0.730	37.5
Falco peregrinus	Falcon	1.29	0.775	38.6
Rallus aquaticus	Rail	1.28	0.781	38.8
Pandion fluvialis	Balbuzzard	1.26	0.795	39.2
Neophron percnopterus	Egypt'n vulture	1.18	0 848	40.4
Columba ægyptica	" pigeon.	1.13	0 885	41.3
Numenius arquatus	Ceulis	1.11	0.901	41.7
Ortyx coturnix	Quail	1.08	0.927	42.3
Recurvirostra avocetta	Avocetta	1.05	0.954	42.8
Œdicnomus crepitans	Plover	0.926	1.079	43 6
Anas querquedula	Duck	0.864	1.158	44.2
Puffinus Kulhi	Shearwater	0.853	1.170	44.5
Gallinula chloropus	Water-hen.	0.765	1.307	50.3
Numenius arquatus	Curlew	0.761	1.312	50.3
Pelecanus anocrotales	Gray Pelican	0.732	1.365	51.3
Gyps fulvus	Tawny Vulture.	0.679	1.473	53.3
Otogyps auricularis	Oricou	0.664	1.473	53.9
Pterocles exustus	Running Pigeon	0.664	1.508	53.9
Procellaria gigantea	Giant Petrel	0.640	1.561	54.9
Anser sylvestris	Wild Goose	0.586	1.708	57.4
Meleagris Gallopavo	Turkey	0.523	1.910	60.6
Anas clypeata, female	Duck	0.498	2.008	62.2
" " male	"	0.439	2.280	66.2

Marey and Müllenhoff are all easily accessible in print, they will not be repeated here; but the following table is considered more valuable than any of them. It has been compiled from "L'Empire de l'air" of Mr. Mouillard, a very remarkable book, published in 1881, which contains descriptions of the flight of many birds and accurate measurements of their surfaces and weights.

Mr. Mouillard adopted a more rational method than other observers. Instead of merely measuring the surface of the wings, he laid the bird upon its back on a sheet of paper, projected the entire outline, and then measured the total area from which it gains support. The compilation has been made by Mr. Drzeweicki for a paper presented to the International Aeronautical Congress at Paris in 1889, in which he states the general law more accurately than his predecessors, by calling attention to the fact that the ratio of weight to surface will vary somewhat with the structure of the bird, and that the result will be that those possessing the lesser proportionate surface must fly faster in order to obtain an adequate support at the same angle of incidence.

I have added the last column in the table, showing the speed required to sustain the weight of a flat plane loaded to the same proportion of weight to surface as the bird, at an angle of incidence of 3°. This speed merely approximates to the real flight of the bird, because it takes no account of the concavity of the wings, which, as previously explained, increases the effective bearing surface of the animal; but it would require experimenting with each and every bird tabulated in order to give the true and varying coefficients.

(TO BE CONTINUED.)

THE ARMOR-PLATE TRIALS.

THE last of the series of armor-plate tests, to which reference has been made in our columns, took place at the Indian Head proving grounds on January 13. Two plates remained to be tried—a low-carbon, untreated plain steel, and a high-carbon nickel-steel treated by the Harvey process; both plates were made by Carnegie, Phipps & Company. These plates were originally of the same size as the others treated, 6 × 8 ft., and 10½ in. thick. In consequence of a defect in the nickel-steel plate 20 in. were cut off, leaving it that much shorter; while to take out a warp in the plain steel plate, caused by successive temperings, the edges had been planed down about 1 in., leaving the center of the plate of full thickness. To offset the difference in the size of the plates, only three 6-in. shots were fired at the nickel-steel plate, these being aimed at the points of an isosceles triangle, 2 ft. from the upper edge and the two sides; this was one shot less than in the other tests. One 8-in. shot was fired at the center.

In the tests alternate shots were fired at the two plates, beginning with the plain steel. That plate was practically wrecked, all four of the 6-in shots having gone through it and lodged in the backing. The second shot broke off the upper right-hand corner, and the others, besides fracturing, produced cracks in several directions. The 8-in. projectile went through the plate and backing, and was picked up 50 ft. distant, having been very little injured.

The first of the three 6-in. projectiles fired at the nickel-steel plate penetrated it to a depth of 9 in. and rebounded. The second shot acted very much the same way as one of the shots at the nickel-steel plate in the previous trials. The point of the projectile was apparently welded to the plate, and the remainder was broken up into pieces. The penetration was estimated at about 4 in. The third 6-in. shot at this plate remained in the plate, the base projecting 6½ in. It is stated that no cracks were developed by any of these shots. The fourth shot, which was from the 8-in. gun, and which was fired at the center of the plate, went through the plate and backing and remained imbedded in the sand beyond. After this shot three cracks appeared, one extending from the center to the top of the plate, and the other to the lower right and left-hand corners; each crack passed through one of the marks left by the 6-in. shot, practically separating the plate into three parts. It should be borne in mind that the shots at this plate were grouped more closely together than had been done upon any of the other plates tested.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.

CHEMISTRY APPLIED TO RAILROADS. XXV.—BEARING METALS.

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.

(*Continued from page 16.*)

THE question as to what metal to use for bearings under cars is one which will be recognized when mentioned as of the very highest importance to railroads. It is believed by many that the bearing metal is largely at fault for those annoying delays in transportation due to what are known as "hot-boxes," and although our studies and investigations have hardly led us to such a conclusion as this, yet it cannot be denied that the metal itself used in the bearings has a good deal of influence upon the successful movement of trains. The importance of the question is likewise re-enforced by another consideration—namely, loss of the metal by wear. When it is considered that the bearing metal is expensive, costing possibly anywhere from 12 to 20 cents per pound, and that each car, on the average, loses eight pounds of this metal for every 25,000 miles that it runs, it is readily seen that the item of wear of bearing metal comes in as quite an important factor in the cost of operating a railroad. It only requires a little calculation based on the above data to show that on any large railroad the loss of bearing metal by wear might readily amount to from $100,000 to $150,000 per year.

In view of both of these considerations we have devoted a good deal of time and experimentation to the question of what kind of bearing metal is the best to use. Some 20 years ago the standard bearing metal was a copper-tin alloy, seven pounds of copper to one pound of tin, commonly known as "cannon bronze." This alloy is, even to this day, possibly with slight modifications in the proportions, largely used for bearings, but, as will be seen a little later, we think, not at all wisely. The first experiments made with bearing metal alloy were to compare this copper-tin alloy with what will be called the standard phosphor-bronze bearing metal, and which will be described in detail a little farther on. The results of these experiments, which were quite extended, proved conclusively two things: First, that the copper-tin alloy was much more liable to heat under the same state of lubrication than the standard phosphor-bronze bearing metal, and, second, that the rate of wear with the copper-tin alloy was nearly 50 per cent. greater than that of the standard phosphor-bronze bearing metal—that is to say, if the standard phosphor-bronze lost a pound of metal every time a bear-

* These articles contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July and August numbers, on How to Design a Paint; No. XX, in the September number, on Disinfectants; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative; No. XXIII, in the November and December numbers, on Soap; No. XXIV, in the January, 1892, number, on Steel for Springs.

ing went 25,000 miles, the copper-tin alloy would lose 1¼ lbs. under the same conditions. These experiments led to the adoption of what has already been called the "Standard Phosphor-Bronze Bearing Metal," as the almost exclusive metal to be used for car bearings on the Pennsylvania Railroad, and for a period of years following these experiments nothing else, practically, was used for this purpose.

The *Phosphor-Bronze Bearing Metal* will bear a few words of elucidation and explanation. It is well known by those who are informed on the progress of metallurgy that Messrs. Levy and Kunzel made experiments, now nearly 20 years ago, with the idea of developing an alloy which could be successfully used in making cannon. These experiments were carried on on a large scale, and the results have been published in a *brochure*, which has been furnished to most of the large governments of the world. The experiments of these gentlemen culminated apparently in the development of an alloy of copper, tin, and phosphorus which had quite remarkable properties. The addition of phosphorus to a copper-tin alloy seems to increase the tensile strength and elongation, and to make it a very much easier metal to manipulate in the foundry—that is to say, phosphorus being present in a copper-tin alloy, a very much larger percentage of sound castings will be obtained than if the phosphorus is not present; also, these castings will have greater tensile strength and greater elongation. Following the knowledge of this fact came another one which, so far as bearing metals are concerned, is perhaps of equal importance—namely, Mr. C. J. A. Dick, of London, discovered that the addition of lead to a copper-tin-phosphorus alloy gave a resulting alloy which under abrasion was very much superior to anything at that time known, and he accordingly took out a patent for a phosphor-bronze containing lead to be used as bearing metal. It is practically this metal which was used, as above referred to, for a period of time as the standard bearing metal of the Pennsylvania Railroad Company.

For quite a long time while Mr. Dick's patent was in force this metal was made of standard composition and quality by the Phosphor-Bronze Smelting Company, of Philadelphia. Ultimately, as the time of the patent was about to expire, and as other manufacturers recognized the value of the phosphor-bronze bearing metal and began to prepare to make it, it became essential for the Pennsylvania Railroad Company, in order to protect its interests, to prepare specifications for this metal, which was accordingly done. These specifications are as follows:

PENNSYLVANIA RAILROAD COMPANY.

Specifications for Phosphor-Bronze Bearing Metal.

From this date Phosphor-Bronze Bearing Metal will be purchased in amounts of 20,000 pounds, or some whole multiple of this number. Manufacturers will be required to notify the General Superintendent Motive Power, at Altoona, when they are ready to ship 20,000 pounds, and await the arrival of the Company's Inspector, and have proper assistance and all facilities ready for shipping the metal as soon as the Inspector arrives.

The Inspector will see the metal weighed and shipped, and will select three half pigs to represent the shipment. He will also be at liberty to reject any pigs in which want of uniformity in the constituents is evident to the eye.

Mixed borings from the three half pigs will be analyzed, and the shipment will be accepted or rejected on this analysis.

The metal desired has the following composition:

Copper	79.70 per cent.
Tin	10.00 "
Lead	9.50 "
Phosphorus	0.80 "

Shipments will not be accepted if the analysis as above described gives results outside the following limits: Tin, below 9.00 per cent., or over 11.00 per cent.; Lead, below 8.00 per cent., or over 11.00 per cent., and Phosphorus below 0.70 per cent., or over 1.00 per cent., nor if the metal contains a sum total of any other substances than Copper, Tin, Lead, and Phosphorus in greater quantity than 0.50 per cent.

THEODORE N. ELY,
General Superintendent Motive Power.

Office of General Superintendent Motive Power, Altoona, Pa., June 14, 1889.

The above is the second revision of these specifications. The specifications seemed to be sufficiently clear on inspection and very little difficulty has arisen in regard to them. All the manufacturers, of whom there are now some five or six, seem to be competent to make metal which will come within the limits given at the end of the specifications, and it is very rare indeed that we have occasion for complaint or to reject a shipment. Since the phosphorus is the most expensive constituent in the metal, it might be thought there was no real reason why there should be an upper limit, and that in reality we would be glad to have as much phosphorus as possible. In the first specifications issued no upper limit was provided, and it was found that, either on account of carelessness or of unequal distribution of the phosphorus, we occasionally got metal considerably higher than the limits given. A direct experiment with this high phosphorus metal showed that it was so extremely fluid that it was difficult to hold it in the sand, and accordingly we placed an upper limit of phosphorus.

We believe the manufacturers use phosphorus enough, so that if all of it should get into the metal it would make about 1.00 per cent. The average of our analyses shows not far from 0.80 per cent. in the finished metal as we receive it, the balance being lost in the process of introducing the phosphorus.

It will be observed that practically no other substances are allowed to be present in this alloy except copper, tin, lead, and phosphorus. There is a twofold reason for this: First, zinc is a very much cheaper constituent than any of the others except lead, and the tendency of the manufacturers would be to introduce zinc to the extent of a few per cent. There would be two reasons for this tendency: First, the diminution in the resulting cost of the alloy; and, second, it is well known that the quadruple alloy of copper, tin, lead and zinc is a much easier manipulated metal than a copper-tin alloy, or, indeed, than a copper-tin-lead alloy. The phosphorus undoubtedly facilitates the foundry manipulation of the metal, but so does the zinc; and without any control over the metal, and limitations moderately rigidly enforced the tendency would be to give a copper-tin-lead-zinc alloy with very much less phosphorus. While we believe in the value of zinc in copper-tin-lead alloys, we think it advisable to introduce it ourselves in our own foundry, if we decide to put it in, and accordingly, as will be observed, the limitations are moderately strict on this point. There is still another reason for excluding the introduction of other substances than copper, tin, lead and phosphorus—namely, according to present experience a copper-tin-lead alloy containing phosphorus is the best bearing metal known. If now we allow other substances to be introduced it becomes more difficult to locate the cause of trouble when hot-boxes arise than if we have a standard bearing metal. It is not uncommon for the laboratory to receive bearings from the service which have heated with the request to know if there is anything in the bearing metal which will account for the difficulty. If old junk and miscellaneous metals are allowed to be used in the bearing metal we would, of course, find it very difficult to say that the cause of the hot-boxes must be looked for otherwheres than in the bearing metal. The effect of this on the efficiency of the service will be readily appreciated by any railroad operating officer.

It is perhaps worthy of note that the success of the phosphor-bronze bearing metal has been so great that attempts have been made by a number of parties to secure the same metal in other ways. The most notable attempt of this kind has been the effort to sell to the railroad companies a phosphor-tin and then allow them to make their own bearing metal by using the proper proportions of the phosphor-tin to secure the right amount in the resulting alloy of both tin and phosphorus. So far as we know there is really no objection to this method of making the bearing metal, but, so far as our experience has gone, it is extremely difficult to obtain in the market a phosphor-tin rich enough in phosphorus so that the amount required in our specifications would appear in the finished bearing. The manufacturers of the phosphor-tin alloy do not apparently sufficiently understand their work to enable them

to make an alloy containing 7.00 or 8.00 per cent. of phosphorus, at least at a price which will enable this alloy to compete with the phosphor-bronze as it is now ordinarily made. Of course, if the consumers of the phosphor-bronze bearing metal are willing to accept less phosphorus than is characteristic of the metal described in the above specifications it is undoubted that a good alloy could be made in this way. The lower limit of phosphorus in our specifications is more a commercial question than one of actual value in the service so far as we know. Our position in this matter is as follows: Every melting of the metal causes a little loss of phosphorus, and as we do not know how many times we may want to remelt this metal we start with a good lot of phosphorus, the lower limit being 0.70 per cent. We have no experiments to prove that if the finished bearing has 0.40 per cent. of phosphorus in it the bearing would not be just as good in service, but as the scrap bearings are remelted we are sure the scrap would not be as valuable as it would if it had 0.70 per cent. It is entirely probable that the makers of phosphor-tin will learn within a short time how to make an alloy of phosphorus and tin which shall meet every requirement, and if this is possible it will introduce another source of competition in bearing metal material which will undoubtedly redound to the benefit of the consumers.

Notwithstanding the successful results obtained with the standard phosphor-bronze bearing metal it was not deemed advisable to allow the question to rest here, and accordingly with more or less frequency during all the time since the phosphor-bronze bearing metal was established as standard experiments have been made with other alloys to see if any improved results could be obtained. It is entirely possible that not less than 20 to 25 different bearing metal alloys have been experimented with during the past 15 years. The usual method of experimentation is to have either eight, or twelve, or sixteen bearings cast of the standard phosphor-bronze and a like number of the metal under trial. These bearings are all carefully weighed and stamped, a record being made in a book kept for the purpose of these weights and numbers. They are then put in service, usually on engine tenders, a standard phosphor-bronze bearing and a trial bearing being on opposite ends of the same axle. Also one-half the trial bearings and one-half the standard bearings are on each side of the tender, so as to eliminate as much as possible any conditions favoring one bearing or the other. This arrangement, as will be observed, brings a standard bearing, we will say, on one side of the tender next to the engine. Following down that side the next would be a trial bearing, the next a standard bearing, and the next a trial bearing, and on the opposite side the reverse. This method, it will be observed, is strictly a comparative one. No attempt is usually made to keep a record of the mileage, since it is found that the wear of bearings is very variable compared with the mileage, possibly due to location where the work is done—that is, whether the work is largely on grade or curves, also due to the state of lubrication, and also due to the variation in the load in the tender. On the other hand, the loss of metal by wear of the trial bearing is strictly comparative with the standard bearing metal, and the results obtained in this way are believed to be very valuable indications. If the trial on tenders shows that the proposed new alloy has promise, a second trial may be made more extended on locomotive tenders, or possibly two or three hundred bearings of each kind may be put on cars. This has been done in several cases. At the end of the trial the bearings are removed from service and re-weighed and the loss of metal of each trial bearing is compared with the loss of metal of its opposite standard bearing. Averages, of course, are made of the whole lot. It frequently happens that, owing to the exigencies of the service, a trial bearing or its opposite may be lost, and in making up the averages these odd bearings are rejected. During the trial, of course, careful attention is paid to the heating, which is regarded as of great importance. Some trial alloys have actually not run three days without one-half or two-thirds of them heating. Under such conditions the trial is, of course, discontinued at once.

It would hardly be worth while to go into the details of all the experimental alloys that have been tried in the manner described above. It is perhaps sufficient to say that three points have been brought out quite clearly so far as we are concerned—namely:

First, the loss of metal by wear under exactly the same conditions diminishes with the increase in lead.

Second, the loss of metal by wear under the same conditions diminishes with a diminution of tin.

Third, the phosphorus in a copper-tin-lead-phosphorus alloy, apparently is very much more valuable in the foundry than in the service; indeed, its principal value, so far as the service is concerned, consists in the help that it gives in getting sound castings.

We have no evidence to show that the phosphorus has any valuable influence on the wear except as stated above. In other words, if we had two bearings of practically the same proportions, one made of copper, tin, lead alone, and the other made of copper, tin, lead and phosphorus, and both were equally sound castings, we have no experiments that indicate that the one containing phosphorus would wear any better than the one without phosphorus.

In view of the results stated above, the question arose some three or four years ago with some prominence as to how much lead and how little tin we could get along with. Quite a number of experiments were made on this point, with the result of finally reaching the following composition as the best that could be obtained with our present knowledge—namely:

Copper	77.00 per cent.
Tin	8.00 "
Lead	15.00 "

This alloy from the letter assigned to it in the experimental work done is known as "Ex.B" metal. It will be observed that in the figures given above there is no phosphorus, and this was the case with the experimental alloy which led to the adoption of the figures mentioned. On the other hand, as will be readily understood, there are considerable amounts of phosphor-bronze scrap constantly coming back to the foundry for remelting. Accordingly, such a formula was devised as would enable this scrap to be used in making the standard Ex.B metal, and at the same time would give the advantage in foundry practice of having a small amount of phosphorus in the alloy. We give below working formulas which enable a foundry to use larger or smaller amounts of scrap, depending on the amount received from the service. It will also be fair to state that we deem the presence of a small amount of phosphorus in the alloy as of sufficient importance in the foundry, so that if there is no scrap we recommend to put in new standard phosphor bronze. These points are covered in the working formulas as follows:

Copper	105 lbs.	90 lbs.	72½ lbs.
Phosphor-Bronze, New or Scrap.	60 "	80 "	100 "
Tin	9¾ "	7½ "	5¼ "
Lead	25½ "	22½ "	22 "

These formulas all give a bearing metal of about the following composition:

Copper	76.50 per cent. to 76.80 per cent.
Tin	8.00 "
Lead	15.00 "
Phosphorus	0.50 " to 0.20 "

The above formulas enable the foundry to make a standard bearing metal which, so far as our knowledge at present goes, is the best one known; but there is one point still not covered in these formulas—namely, it is clear, of course, that after awhile the foundry would begin to receive Ex.B scrap, and it would not do to put this in in place of the phosphor-bronze scrap, because the proportions of the constituents are different, and also because the amount of phosphorus in the Ex.B metal is small. Accordingly, a working formula has been calculated out which enables the foundry to dispose of the Ex.B scrap which comes to it. This formula is as follows:

Ex.B Scrap	80 lbs.
Phosphor-Bronze, New or Scrap	20 "
Copper	76 "
Tin	7 "
Lead	17 "

It will be observed that, even in this formula, which was calculated out for the sake of enabling the foundry to use large quantities at one time of the Ex.B scrap, some new or scrap phosphor-bronze is used, the object being to keep up the phosphorus in the bearings to not less than about 0.2 per cent.

The above series of working formulas will enable any foundry to make bearings like the standard bearings of the Pennsylvania Railroad without any difficulty and provide for the use of their scrap bearing metal. It is perhaps advantageous to add that the formulas calculate for 200-lb. pots, and that in the melting it is not essential to add the copper to the pot and melt it down before adding the other constituents. In actual practice the copper and scrap together with the new phosphor-bronze are all charged at once, care being taken to keep the pot covered with powdered charcoal during melting. The lead and tin are not added until after the pot is taken from the fire. It is also fair to say that there is one characteristic in regard to the foundry practice, which it is important to observe—namely, the metal must not be cast at too high temperatures. A very injurious segregation of the constituents takes place if the metal is cast, even in as small a casting as a car bearing, at too high temperatures. Instead of the fine-grained fracture, which is characteristic of metal properly treated, bearings that are poured too hot are coarse crystalline, and in every sense inferior. In the early days of the use of phosphor-bronze very serious difficulty arose from this cause. It is customary in a well-organized foundry to temper the metal, as it is called, for pouring, by the addition of borings from previous bearings. It is, of course, understood that no bearings are sent to the service with the foundry skin on the part that rests on the axle. This is always taken off and the bearing bored out to the proper radius before the bearings are turned out. These borings are used for tempering. Of course the tin and lead added to the metal after it is taken from the fire always temper it a little bit. We know of no rule by which the actual temperature fit for pouring can be determined, but the general practice should be to cast at as low temperatures as will give successful work.

While upon the subject of bearing metal it is perhaps fair to discuss a little the question of lead lining. It is doubtless well known that the common practice now made use of, and which is recommended everywhere for bearings, is to lead line everything which goes into the service. The principal reason for this lining of lead on the inside of the bearing is to furnish a layer of soft, rather easily displaceable metal which will enable the bearing to adapt itself to the worn journal without giving an excessive pressure per square inch. There seems little doubt but that the practice of lead lining diminishes the difficulty of adapting the bearings to worn journals very greatly. It is obvious that it will be impossible to have the bearings turned to the same radius as every worn journal in service, and the lead-lining device meets this difficulty in a very satisfactory way.

It has been stated once or twice in the course of the preceding remarks that it is believed the Ex.B metal represents the best composition for bearing metal now known. It is not at all intended to claim that it is the best that can be developed. All we can say is that all the experiments made show that, both in regard to heating and in regard to loss of metal by wear no other bearing metal that we have experimented with gives as good results as the Ex.B metal. It is entirely possible that a still further diminution in tin, and increase in lead, might give better results. Just where the line should be drawn as a finality it is impossible to say at the present moment. Experiments have been made diminishing the tin in the Ex.B metal one-half, but a very funny difficulty was met with in attempting to make bearings of such an alloy. It is well known that lead and copper do not alloy, and on trying to make a bearing with about 20 per cent. of lead and 4 per cent. of tin, the remainder being copper, it was found almost impossible to get a homogeneous alloy due to the separation of the lead. Apparently one function of the tin, in the triple alloy of copper, tin and lead, is to hold the lead alloyed with the copper. It is quite probable that a small diminution in tin from what is characteristic of the Ex.B metal might take place, and also possible that a small increase in lead might take place. We have not yet finally put this question at rest. It is also possible that the introduction of other constituents into the bearing metal alloy, or, indeed, other combinations of the five or six metals available for bearing metal purposes—namely, copper, tin, lead, antimony and zinc, either with or without phosphorus, might give a bearing metal better than anything else we now know of. This field still remains for experiment.

The question of the crushing or distortion of the bearing under the pressures used is one that has received considerable attention in the course of our experiments. No difficulty has been experienced on this point, either with the standard phosphor-bronze, or with the standard Ex.B metal. Some of the white metal alloys, however, notably the alloy of lead and antimony, either with or without a small addition of zinc, or a little bit of copper, or an alloy of lead, tin and antimony, or, indeed, any of the white metal alloys made from zinc, tin, lead and antimony, have so much difficulty from this cause, that we do not know of any successful car bearings made wholly from white metal. Accordingly, it is customary when trying to use any of these white metal alloys for bearings, to put them inside of a stronger shell, giving rise to the well-known filled car bearing. There is a good deal of chance for experiment in this field yet, and we are frank to say that our experiments have not covered as much ground in this direction as we could wish. There is some knowledge which indicates that the use of a white metal alloy of the right composition would possibly diminish some of the difficulty now experienced with the present standard bearing metal—notably, a less tendency to heat, and possibly a diminution in friction. This field remains, however, for further experiment, and experiments on this point are in progress. Experiments on bearing metals containing aluminum have been undertaken, but no results have yet been obtained.

In the next article we will try to answer the question, "How to Make a Specification," and hope to follow this by another article on "Sampling and Enforcement of Specifications."

(TO BE CONTINUED.)

Foreign Naval Notes.

A NEW Russian armored ship has recently been completed at Sebastopol, and will be added to the Black Sea fleet. This ship, which has been named *George the Victorious*, is 340 ft. long, 69 ft. beam, 26 ft. deep, and 10,280 tons displacement. The engines will work up to 16,000 H.P. with forced draft, and will give, it is expected, a speed of 14 knots with natural draft, and 17.5 knots with forced draft. The main battery consists of six 12-in. guns mounted in barbette, and seven 6-in. guns on the battery deck. The secondary battery includes eight Baranooski rapid-fire guns and six 37-mm. rapid-fire guns; there are also seven torpedo-tubes.

ON December 18 a test of a Cammell solid steel armor-plate was made on the *Nettle*, at Portsmouth, England. The plate was 10½ in. thick and weighed 10 tons. Five rounds were fired from a 6-in. gun at a distance of 30 ft., a charge of 48 lbs. of powder being used, with projectiles weighing 100 lbs. Three of these were Holtzer armor-piercing shell, and it is stated that two of them rebounded, doing but slight damage, while the third remained in the plate, but did not crack it. The other two projectiles were Palliser chilled shot, and did no damage to the plate. The plate was made by a new process, which is kept secret.

A NEW ENGLISH CRUISER.

ONE of the latest additions to the English Navy is the cruiser *Thetis*, which is one of three built by James & George Thompson, of Clydebank, Scotland. This vessel is a second-class cruiser of the following dimensions: Length, 300 ft.; breadth, 43 ft.; depth, 22 ft. 9 in.; average draft, 16 ft. 6 in.; displacement, 3,460 tons. She has a protective deck extending the whole length of the vessel in the form of a flat arch, the crown of which rises about 1 ft. above the water-line at the center of the ship, and slopes down to a point about 4 ft. below the load-line at the sides. This deck is 2 in. thick on the slope and 1 in. on the crown, and covers the engines, boilers and other machinery and the magazines. Protection for the parts of the engine which are above this deck is obtained by a belt of 5-in. armor with teak backing surrounding the engine hatchway. The ship is divided into 80 water-tight compartments, and has an inner bottom under the engine and boiler space.

LOCOMOTIVE RETURNS FOR THE MONTH OF NOVEMBER, 1891.

Name of Road.	Number of Locomotives on Road.	Number of Locomotives in Service.	Mileage of Locomotives. Total.	Mileage of Locomotives. Average per Engine.	Average Number of Passenger Cars per Train.	Average Number of Loaded Freight Cars per Train.	Coal Consumed per Mile. Passenger Train Mile.	Freight Train Mile.	Working and Switching Mile.	Average for all Engines.	Per Passenger Car Mile.	Per Loaded Freight Car Mile.	Cost of Locomotives per Mile. Repairs.	Fuel.	Oil, Waste, Tallow, etc.	Other Accounts.	Wages, Engineers and Firemen.	Cleaning and Attendance.	Total.
							Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Atchison, Top. & Santa Fé.	802	706	2,167,779	3,070	....	....	.....	.....	.....	85.65	.....	....	5.41	7.20	0.31	0.14	6.68	1.50	21.24
Canadian Pacific	567	...	1,824,895	3,219	....	.....	.....	.....	.....	69.81	.....	....	3.92	11.02	0.37	....	5.33	1.16	21.80
Chesapeake & Ohio*	...	244	802,044	3,287	4.64	22.81	68.40	131.55	56.05	100.88	14.76	5.76	3.75	3.56	0.36	1.72	6.04	0.28	15.71
Chic., Burlington & Quincy	...	480	1,723,680	3,591	4.56	18.08	.....	.....	.....	91.45	.....	....	3.68	6.41	0.21	0.35	6.63	...	17.28
Chicago & Northwestern	...	846	2,807,531	3,318	....	.....	.....	.....	.....	90.14	.....	....	3.20	8.01	0.36	....	6.32	0.78	18.67
Chicago, Rock Is. & Pacific	...	536	1,814,571	3,385	....	.....	.....	.....	.....	61.18	.....	....	2.69	6.10	0.23	...	6.53	....	15.55
D., L. & W., Main Line	208	200	693,725	3,469	....	.....	.....	.....	.....	80.44	.....	..	2.94	6.18	0.35	....	5.97	...	15.44
Lake Shore & Mich. South.	560	536	1,792,960	3,345	...	....	55.36	84.07	....	60.13	.....	....	3.01	4.79	0.16	....	6.97	0.19	15.12
Louisville & Nashville*	...	357	1,723,336	†3,772	5.08	15.76	61.16	103.70	48.43	79.84	12.80	6.35	4.41	6.55	0.26	1.33	6.16	0.58	19.29
Manhattan Elevated	...	276	821,746	2,977	....	.....	.....	.....	.....	38.91	.....	....	2.40	7.90	0.30	...	8.90	....	19.50
Milwaukee, Lake S. & W.	112	103	273,040	2,651	....	.....	.....	.....	.....	80.03	.....	...	2.95	11.95	0.29	....	6.09	1.16	22.44
N. Y., Lake Erie & West.‡	...	617	1,787,783	2,897	4.60	21.20	89.50	127.00	71.30	.....	19.30	6.00	4.92	7.64	0.40	1.92	7.28	1.08	23.24
N. Y., Pennsylvania & Ohio	...	264	703,181	2,664	5.10	18.20	74.30	132.00	68.70	.....	14.60	7.20	4.32	6.76	0.32	2.36	6.78	1.04	21.58
Ohio & Mississippi	114	...	385,655	3,383	....	.....	.....	.....	.....	.....	.....	....	3.76	2.99	0.24	1.09	5.50	1.39	14.97
Old Colony	...	220	567,598	2,580	...	.....	.....	.....	.....	60.55	.....	....	3.64	12.11	0.60	....	6.84	0.82	24.01
Philadelphia & Reading	...	...	1,789,650	......	....	....	....	.....	.....	81.23	.....	....	3.64	4.60	0.32	....	5.74	0.38	14.68
YEAR ENDING SEPT. 30, 1891.																			
Boston & Maine	...	...	12,908,812	......	....	.....	.....	.....	.....	50.26	.....	....	2.64	10.53	0.28	0.10	6.19	0.56	20.30

* Five empty cars rated as three loaded ones. † Average for engines in revenue service only. ‡ Two empty cars counted as one loaded car.

The armament of the ship is not heavy. It consists of two 6-in. guns, one mounted on the forecastle and the other on the poop, and of six 4.7 in. rapid-fire guns mounted in broadside. The secondary battery includes eight 6-pdr. Hotchkiss, one 3-pdr. Hotchkiss and four 5-barrel Nordenfelt guns. There are also four torpedo-tubes, one at the bow, one at the stern and two under the poop. This armament is about the same as will be carried by the new cruiser *Detroit*, which is only 2,000 tons displacement.

On the steam trial the engines of the *Thetis* developed 7,523 H.P. with natural draft, and 9,946 H.P. with forced draft, exceeding the contract power. The speed trials have not yet been made.

A MEXICAN CRUISER.

The accompanying illustration, from *Le Yacht*, shows the cruiser *Zaragoza*, recently completed at Graville, France, by the Forges et Chantiers de la Mediterranée. The *Zaragoza* is built for the Mexican Government, and is intended for a school-ship for its navy. The ship is 213.2 ft. long; 32.8 ft. beam; 18 ft. deep; 14.1 ft. mean draft, and 1,200 tons displacement. She is of steel, and the engines have worked up to 1,300 H.P. in the preliminary trials, giving a speed of 15 knots. She carries three masts and is bark rigged. The armament consists of four 12-cm. (4.72-in.) rifled guns, two 57-mm. (2.24-in.) rapid-fire guns, and two 37-mm. (1.46-in.) revolving cannon.

SCHOOL-SHIP FOR THE MEXICAN NAVY.

Manufactures.

The New Northern Pacific Shops.

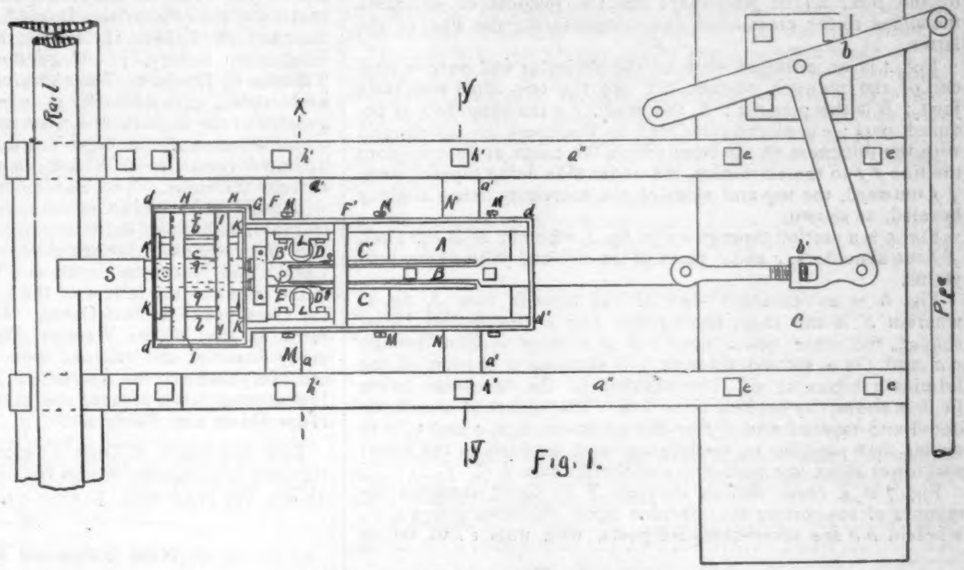
THE new shops of the Northern Pacific Railroad, at Edison, Wash., were formally opened, January 1. The plant covers 70 acres of land, and the floor space of the buildings aggregates 221,370 sq. ft. The dimensions of the various buildings are as follows: Coach repair shop, 100 × 243 ft., two stories high, the cabinet shop being located in the second story; machine shop, 120 × 244; wood working shop, 90 × 152; engine-house and steam-heating room, 42 × 74; paint shop, 90 × 242; paint-shop storehouse, 35 × 90, two stories; freight repair shop, 90 × 302; boiler, tank and copper shop, 80 × 321; engine house for machine shop, 40 × 40; office and storehouse, 43 × 156; blacksmith shop, 80 × 192; boiler iron storehouse, 25 × 50; coal and iron storehouse, 28 × 150; oil house, 43 × 60; two lavatories, 26 × 42 each; dry kiln, double, 40 × 72; dry lumber shed, 40 × 225. There are also two transfer tables, one 40 ft. in width and the other 70 ft., each having a range of travel of 325 ft. All the new machine tools for these works were furnished by Manning, Maxwell & Moore, New York. The roof trusses were supplied by the Union Bridge Company, of Athens, Pa. The machinery for collecting and removing shavings and sawdust from the woodworking shops was furnished by the Allington & Curtis Manufacturing Company, of Saginaw, Mich. The dry kiln apparatus is from the factory of the B. F. Sturtevant Company, of Boston. The oil-house tanks were built by Messrs. Kinney Brothers, of St. Paul. Messrs. Cofrode & Saylor, of Philadelphia, supplied the 10 small turntables which are used in connection with the system of transfer tracks extending through the buildings. J. A. Fay & Company

supplied much of the woodworking machinery. The Babcock & Wilcox Company furnished the six boilers, having an aggregate capacity of 624 H.P. The Industrial Works of Bay City, Mich., put in the electric cranes and transfer tables.—*Railway Age.*

The Fox Torpedo Placing Machine.

THE accompanying illustrations show a machine intended to place torpedoes upon the track, which appears to have many advantages in point of simplicity and effective working. It can be operated from a signal tower at the same distance that a semaphore signal can, and can also be arranged in such a way that it will be worked by the passage of the trains.

In the illustrations fig. 1 is a horizontal plan of the machine, showing the rail attachments, the crank and crank connections and the pipe or wire attachment; fig. 2 is a vertical plan of the magazine with the casing cut away; fig. 3 is a cross section through the line *x x*, fig. 1; fig. 4 is an enlarged plan of the projector; fig. 5 is a section on the line *a a*, fig. 4; fig. 6 shows an enlarged plan and two sections of the case *S*, fig. 1, in which the fulminate boxes are inserted; fig. 7 is a cross section of the supports and cover of the machine on the line *y y*, fig. 1; fig. 8 is a perspective view of the machine.



FOX'S TORPEDO PLACING MACHINE.

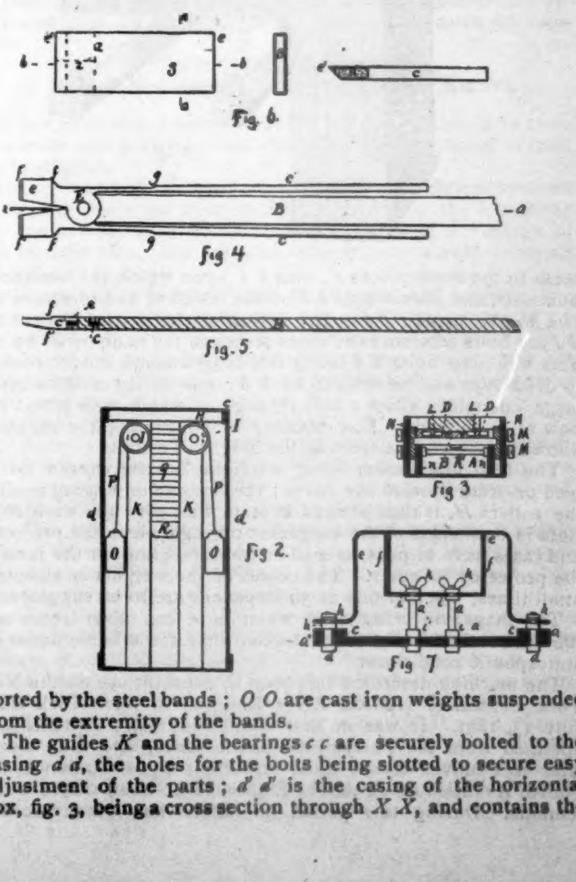
The magazine is of the simplest kind, and the principal parts as well as the magazine are made of steel and are very durable, the only precaution being an occasional coating of the working parts with plumbago or carburet of iron to prevent rust. The parts are all interchangeable and can be readily replaced in case of breakage.

The magazine or storage chamber shown in vertical section, fig. 2, with the casing cut away is 5 × 7¾ in. inside sectional area by 16 in. total depth, and will hold 30 double torpedoes, which are fed with absolute certainty by the aid of the weights *o o* to the projector, which is contained in a horizontal box 16½ in. long, 5⅞ in. wide, and 3⅝ in. deep, firmly riveted to the magazine, and connected to a crank which is hooked up to either the pipe or the wire connections in the usual way.

The operation is by movement of the plunger or center bar *B*, fig. 1, in the direction of the rail, which carries with it the projector *c c*, which first enters the open end *e* of the tin case *S*, fig. 1, and *S* and *c*, fig. 6, three quarters of one inch, when the shoulders *g g*, figs. 1 and 4, passing between the rollers *D D*, fig. 1, cause the long arms of the projector to be pressed toward each other and with the stud *E* acting as a fulcrum spreads the jaws sufficiently to hold the tin case with a very firm grip, and with the continued motion of the plunger carries the said projector and tin case forward until the end of said tin case containing the fulminate rests from 1¼ to 1½ in. upon the rail, in which position it remains until the semaphore is thrown to "clear," when the projector and tin case are again brought back into the exact positions they first occupied before projection. If a train runs past the signal the explosion of the torpedo blows the tin case entirely off the projector; no part of the exploded case can possibly enter the magazine to clog it up.

The projector is made of the best spring steel, and notable in this connection is the fact that if always at danger it will not be liable to lose its elasticity, because the strain upon the neck is reduced to a minimum on account of the length of the arms from the shoulders *g g* to the point at which they rest between the rollers *D D* when at danger, which is three times the length of the jaws from fulcrum *E* to their extremity. The throw of the plunger is 7 in. and the distance from the end of the jaws (when at danger) to the rail is 3 in., which insures the projector from contact with the tread of the car wheels; outside of the spring properties of the projector there is not a spring of any kind used.

Referring to the various parts of the machine, which are indicated by letters in the different figures, fig. 1 is a horizontal plan of the machine, the central figure being the machine which is supported upon screw-threaded posts, which are secured to the iron cross-pieces *a' a' a' a'* bolted firmly to the iron hangers *a'' a''*, which are made to grip the foot of the rail, extending outward therefrom, rest upon and are securely bolted to the wood foundation *C*, which also has securely bolted to it the crank plate with crank and shackle *b* and *b'* attached and showing also the pipe (or wire) connection. In figs. 1 and 2 *d d* is the casing of the magazine in which is contained the torpedoes *Q*, one of which is shown at *S* projected on the rail. *K K* are guides between which the torpedoes are carried upward by the aid of flexible galvanized steel bands *P P*, which pass over the pulleys *I I* and revolve upon the axles *b b*, fig. 1, which are journaled into the guides *K* until they impinge against the rollers *H H*, which are journaled into the bearings at *c c*. *R* is a wood platform upon which rest the torpedoes, and is supported by the steel bands; *O O* are cast iron weights suspended from the extremity of the bands.



The guides *K* and the bearings *c c* are securely bolted to the casing *d d*, the holes for the bolts being slotted to secure easy adjusment of the parts; *d' d'* is the casing of the horizontal box, fig. 3, being a cross section through *X X*, and contains the

grooved slides N N, a cross-head A fitted to move freely in the groove of said slides, a plunger B securely bolted to the said cross-head, one end being reduced in breadth and having a stud E formed upon its extremity, to which are pivoted the two jaws C C of a projector B', the two jaws of which are supported upon a slotted bearer G having a bridge F fitting loosely upon pins secured in the bearer, which prevent the jaws from spreading too much or jarring off the stud; a similar bridge at F' serves the same purpose, the long arms being supported upon the cross-head A, the sides of the projector being reduced at g g to give that portion free play between the rollers D D which are journaled in the ears L L; said ears being bolted to the slides N N. In fig. 3 n n are posts incorporated with the slides and extending to the bottom of the box, forming supports for the said slides. R', fig. 3, is one of three double-ended screws passing loosely and having two nuts each, which impinge against the inside of said slides. M M are screws threaded into the casing of the box, all of which are for the purpose of adjusting the slides to the cross-head and compensating the wear of the latter.

Fig. 4 is an enlarged view of the projector and narrow stud end of the plunger, wherein C C are the two arms with their jaws; B is the plunger; E' the stud; g g the shoulders of reduced part; e is slightly reduced in thickness (to correspond with the thickness of tin from which the cases are made) from the line f f to the extremity, the under side being tapered from f f outward, the top and sides of the extremity being slightly beveled, as shown.

Fig. 5 is a section through a a of fig. 4, wherein E' is the stud, f f the shoulders, c and c' parts of the end and joint of the projector.

Fig. 6 is an enlarged view of the torpedo case S, fig. 1, wherein S is the case, having one end e' closed and chisel shaped, the other end e open; B is a cross section through a a, and c is a section through b b showing a section of the fulminate boxes at d. The position of the fulminate boxes in S is shown by broken lines h h. The object of the shouldered and tapered end f f of the projector, figs. 4 and 5, is to enable that position to easily enter and be flush at the upper and lower sides, the open end e of the tin case S C.

Fig. 7 is a cross section through Y Y, fig. 1, showing the manner of supporting the machine upon the cross pieces a' a', wherein a a are screw-threaded posts, with nuts i i to secure

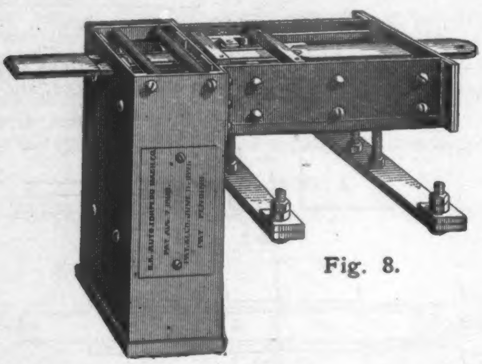


Fig. 8.

them to the cross-pieces a', nuts i' i' upon which the horizontal box rests, and thumb nuts k k on the inside of and to secure the box to the posts; f f is the casing of the box, e e the cover; d d are bolts to secure the cross-pieces to the hangers a'' by the nuts h' h', the bolts d d being left long enough for the cover e to drop over and be secured by h h; one of these bolts being large enough to allow a hole through it which will admit the bow of a padlock. This manner of supporting the machine allows a ready adjustment to the height of rail.

The feed mechanism being a weight balance cannot fail to feed or press upward the cases; the top one impinging against the rollers H, is thus always kept in line with the cavities or slots in both sides of the magazine through which the projector and cases have to pass, as well as in perfect line for the jaws of the projector to enter. The power of the weights is sufficient at all times, whether one or 30 torpedoes are to be supported.

The magazine being made water-tight can never freeze up; the entire machine is so constructed that it is reliable under all atmospheric conditions.

The machine described has been in constant use on the New York Central & Hudson River Railroad in New York since July 13, 1891. It was at first connected with a switch signal operated from the Forty-ninth Street tower, and nine weeks later was moved to the most important signal station in the Fourth Avenue tunnel, that at Eighty-sixth Street, where it still remains. During this period no failure has been recorded against it, although over 200 torpedoes have been used. Competitive trials have shown that for simplicity, storage capacity, and certainty of feed and production and freedom from clogging, no fault can be found with the machine, and that it needs very little care or lubrication. It may be stated that on trial the machine has been worked by trains running from 10 to 40 miles an hour at a distance of 3,960 ft. around two sharp curves. In another experiment the machine was arranged to run continuously for 96 consecutive hours and placed 102 torpedoes each 24 hours without failure of any kind.

Baltimore Notes.

A CERTIFICATE incorporating the Baltimore & Cumberland Railroad Company has been filed with the Secretary of State at Annapolis. The company is incorporated under the general act of the State of Maryland, and names the following promoters of the enterprise: David L. Bartlett, John A. Hamilton, Bernard N. Baker, H. Irving Keyser, of Baltimore City; Buchanan Schley, of Hagerstown; Harry G. Davis and Thomas B. Davis, of West Virginia. The capital stock is fixed at $100,000, with authority to increase to $2,000,000 as the exigencies of the construction may require. The projected road is a continuation of the West Virginia Central Railroad, which is operated from Davis, W. Va., to Cumberland, Md., its present eastern terminus. The Baltimore & Cumberland will connect with the West Virginia Central at or near Cumberland, and will, it is said, be built to Baltimore, which will be its seaboard outlet. The line will pass through Allegheny, Washington, Frederick, Carroll and Baltimore counties. The incorporation of the road is the result of the failure of the promoters to get possession of the Chesapeake & Ohio Canal. The route as laid down is the same as that of the Western Maryland, and it is thought by many financial and railroad men that the control of the Western Maryland may be one of the intentions of the promoters. If that road is not secured the new line will parallel it between Hagerstown and Baltimore.

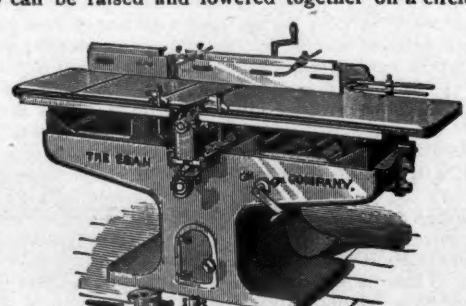
THE Baltimore & Ohio Company has contracted with the Baldwin Locomotive Works for the construction of 12 consolidation, five passenger, 10 switching and 13 ten-wheel engines.

A New Universal Wood-Worker.

THE accompanying illustration represents the latest improved wood worker, of the Egan pattern, which is designated as No. 2½, and is designed for heavy and light work, possessing all the advantages of the No. 1 and No. 2 machines, but of greater capacity. It will be found especially adapted to car work, agricultural work, general wood-working purposes, and for dressing and taking out of twist large timbers and planing a right angle at one operation. The main head is slotted on all four sides, and 19½ in. wide, and, running in connection with the four-sided upright head, makes a very desirable machine for general use, and gives the very best of satisfaction.

The column is one complete casting cored out, heavily braced, and with ample floor space, insuring steady running, free from vibration when the mandrels are running at high speed.

The tables are of extra width and length, planed perfectly true, and made with wide grooves to secure the gaining and paneling frames, and exactly at right angles to the cutter head. Either table can be raised and lowered independent of the other, or they can be raised and lowered together on a circle of the



EXTRA LARGE UNIVERSAL WOOD-WORKER.

head, or straight up and down. All of these adjustments are made from the working side of the machine close to the cutter head, which allows the operator to make the necessary adjustments without going to the end of the machine.

The mandrels are of the best quality of steel, running in self-oiling boxes lined with Babbitt metal. The main mandrel is of

larger diameter, with the pulley on same running between the two back bearings. The front bearing is adjustable, and can be taken off instantly when a change of heads is desired. This mandrel is also fitted up with patent adjustable bearings, by which the boxes, with mandrel and head, are moved back and forth across the bed as desired, instead of making the adjustments by means of the fence, which will be found a great advantage and a great saving in time.

The patent beveling fences are made to adjust across the tables, one fence placed over the main head, and one back of the upright head. Both are made with sliding plates; and, when beveled, the lower part is close to the tables and so constructed as to have no forward motion. It is also arranged to take in posts and springs for holding down the stock while being passed over the cutter head.

The boring attachment on the opposite side is perfectly independent in operation. Two men can work the machine at one and the same time without any interference. It is capable of doing all kinds of boring, routing, rosette-making, dove-tailing table slides, and a general run of this kind of work.

The machine is furnished complete for ordinary work, such as planing out of wind up to 19½ in. wide, squaring one edge up to 4 in. thick at the one operation, and also for surfacing straight or tapering, beveling, jointing, rabbeting, making glue joints, either concave or convex; also circular, straight and wave moldings, chamfering, routing, boring, as well as gaining, grooving, panel-raising, ripping, cross-cutting, rosette, cutting, etc., can be done to advantage on this machine.

For information in regard to this machine, application should be made to the Egan Company, Nos. 194-214 West Front Street, Cincinnati, O.

Signals.

The Long Island Railroad Company has recently put in operation a system of block signals on the section between Long Island City and Jamaica, where the traffic of the different branches of the road is concentrated. The blocks are somewhat less than a mile in length, there being 11 towers in a distance of 9 miles. The system in use is one which has been modified by the Company's own practice and arranged by its engineers.

Early in the month it was announced that the New York Central & Hudson River Railroad Company had made contracts for a system of block signals on the Sykes system to extend from Yonkers to Oscawana, near Sing Sing. From Sing Sing to Peekskill the Company has been testing the Hall system, and from Peekskill to Poughkeepsie a contract has also been let to the Johnson Signal Company for equipping the road with the Sykes system, the blocks being a little over two miles apart. From Poughkeepsie to Albany the Sykes system is also to be used, and bids have been asked for for the signals for that section.

West of Albany nothing has yet been done; but it is stated that the directors have decided to adopt block signals for the entire distance to Buffalo.

The Nichol Lubricator.

The accompanying illustrations show the Nichol Gravity

Fig. 1. Fig. 2.

THE NICHOL LUBRICATOR.

Lubricator, fig. 1 being a longitudinal section of a journal box provided with the device, and fig. 2 a cross-section.

It is a mechanical appliance for lubricating car journals, consisting of a frame, as shown in the cuts, by which a felt pad is held up against the journal. This pad draws up the oil from the bottom of the box, and thus keeps a constant supply on the surface of the journal. It is shown so completely in the drawings that little description is needed.

It is simple and durable in construction, the frame lasting indefinitely, unless injured by breaking of box or journal, and the felt lubricating pad will sustain several years' wear without renewal. No waste is required, it has no springs, is perfect in action, requiring the minimum of attention, and can be readily adapted to any form of box or journal.

The lubricator has been in constant use on several railroads for two years past in all temperatures. One Superintendent of Motive Power, on whose road it has been in use, writes of these lubricators that "they worked very satisfactorily in cold weather or hot, and I am satisfied that, with the care that is usually given to an oil-box packed with woollen waste, these lubricators are as good as two to one in favor of the lubricators."

The following test of the Nichol lubricator was made on the Central Railroad of New Jersey from July 17 to October 29, 1891. Four boxes of car No. 468 were lubricated with oil and packed with waste in the ordinary way, and the other four were provided with the Nichol lubricator. During the above period the car ran 18,759 miles. The following shows the oil, waste, etc., used:

FOUR BOXES PACKED WITH WASTE.

6¾ lbs. woolen waste @ .06⅝	$0.45
37½ qts. No. 2 oil @ .05	1.88
	$2.33

FOUR BOXES WITH NICHOL LUBRICATORS.

8 new wicks @ .05	$0.40
16½ qts. No. 2 oil @ .05	0.83
	$1.23

SUMMARY.

Cost per 100 miles for oil and waste	1.24 ct.
" " 100 " " oil and wicks of lubricator	0.66 ct.

The cost of lubrication of car No. 494 with Nichol lubricators from April 30 to October 27, 1891, during which time the car ran 17,890 miles, was as follows:

18 new wicks @ .05	$0.90
33¾ qts. No. 3 oil @ .01¼	0.42
Total	$1.32
Cost of maintaining per 100 miles	0.74 ct.

In this case, two of the new wicks were required to replace two damaged by a defective brass.

These figures speak for themselves, showing remarkable results with even the cheapest grade of oil, and require no comment.

A Model Municipal Electric Lighting Station.

It is seldom that a central electric lighting station is so complete in its appointments that there is little or nothing to criticise or suggest.

After a thorough personal inspection of the different systems operated in the larger cities of the United States, the Allegheny City councils have incorporated all the points of advantage of each in their own, and have, in consequence, a very compact and efficient station.

It is essentially Westinghouse throughout, and consists of a series of independent units, any one of which may act as reserve without interfering with the operation of the others. This is probably the only plan of arrangement that would permit the concentration of so much power and capacity for lighting in so small a space.

In detail, the machinery consists of:

1. Three 13 and 22 × 13 Westinghouse compound engines, belted direct to three 1,500-light Westinghouse alternating current incandescent dynamos, of which two are in general use, while the third is alternately used as reserve.

2. Four 13 and 22 × 13 and one 10 and 18 × 10 Westinghouse compound engines, belted to nine 65-light Westinghouse alternating current arc dynamos, of which four units are sufficient for the service, and the fifth acts as relay.

3. Two 6½ × 6 Westinghouse standard engines, belted to two 100-light Westinghouse direct current dynamos for use as exciters of the field magnets of the alternating generators.

The engines are ranged in rows on each side of the room, and are belted to the dynamos in the center.

All this machinery, transmitting 1,000 H.P., and with a capacity for 4,500 incandescent and 540 arc lamps, occupies a floor space of but 56 × 57 ft. A 6-ton crane over the dynamos and a 2-ton traveler over each row of engines insures promptness in shifting or repairing.

In the boiler-room the same careful attention to details is shown. Six 100 H.P. Erie boilers, of which one acts as reserve, are fitted with Roney stokers, and the coal is loaded direct from the car into a tank traveling on an overhead rail, so hung as to empty the coal into the hoppers of the stokers.

Two pairs of duplex pumps and three injectors, either of which is sufficient for the purpose intended, are guarantees against accident to the feed-water supply.

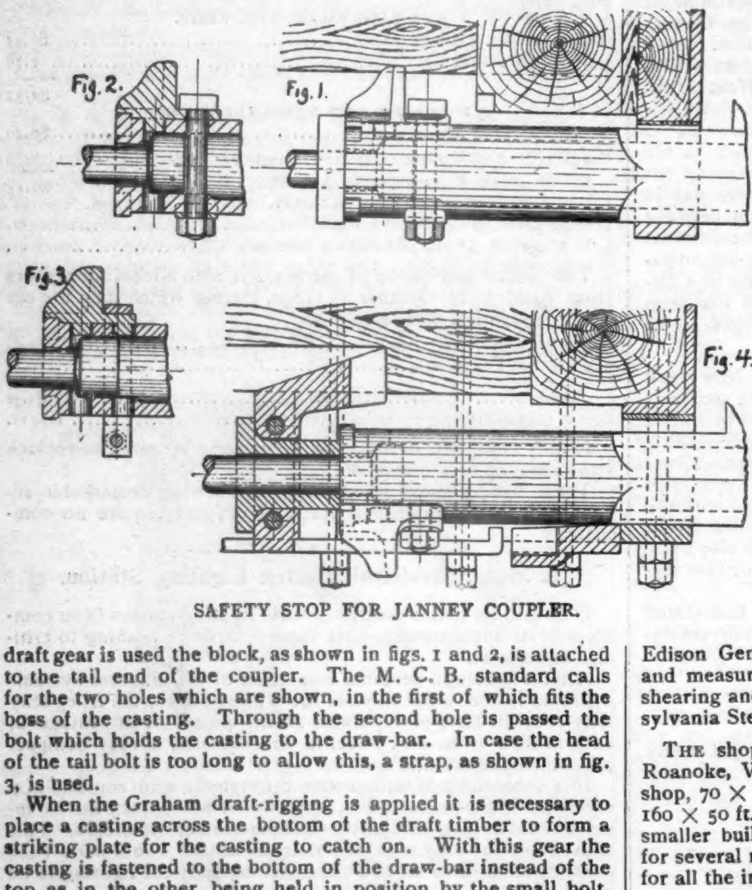
The stokers are operated by a $4\frac{1}{2} \times 4$ Westinghouse standard engine, whose motion is reduced through a screw gear, and a second engine duplicates the first, and is for use in case of accident.

The steam pipe is continuous, and any portion may be disconnected without interfering with the rest of the plant.

On the whole, this station is well designed, well lighted and well managed; and, with its interior finish of natural wood, always kept carefully clean, it presents an air of neatness in striking contrast to many larger and more pretentious stations.

Safety Stop for Janney Couplers.

THE accompanying drawings show a safety stop devised to prevent the trouble caused by the draw-bar pulling out when the continuous draft-rigging is used. Where the M. C. B.



SAFETY STOP FOR JANNEY COUPLER.

draft gear is used the block, as shown in figs. 1 and 2, is attached to the tail end of the coupler. The M. C. B. standard calls for the two holes which are shown, in the first of which fits the boss of the casting. Through the second hole is passed the bolt which holds the casting to the draw-bar. In case the head of the tail bolt is too long to allow this, a strap, as shown in fig. 3, is used.

When the Graham draft-rigging is applied it is necessary to place a casting across the bottom of the draft timber to form a striking plate for the casting to catch on. With this gear the casting is fastened to the bottom of the draw-bar instead of the top as in the other, being held in position by the small bolt. This arrangement is shown in fig. 4.

It can be readily seen that in case of the tail bolt breaking with either construction the casting will prevent the draw-bar being pulled out. The arrangement is devised by the McConway & Torley Company, and is furnished by that company with their couplers, without additional charge.

General Notes.

THE Westinghouse Air Brake Company has announced a reduction in the price of its quick-acting brakes for freight cars from $45 to $40 per set. The Company's increased facilities and improvements at Wilmerding have reduced cost of production.

IN consequence of confusion arising from similarity in names of competing heating companies, the Baker Heater Company has sold its business to William C. Baker, and all business will hereafter be transacted in his name. All orders will be filled by him, and the business will be carried on as heretofore, except that the same will be in the name of William C. Baker, who has no connection with any other concern bearing the name *Baker*. Mr. Baker's long experience and success in the heater business is well known.

THE Baldwin Locomotive Works, in Philadelphia, have lately completed a compound locomotive of the Vauclain four-cylinder type, which is to be submitted to careful tests under the charge of a committee of the Master Mechanics' Association. It is a ten-wheel engine, with six drivers 72 in. in diameter and a four-wheel truck with wheels $33\frac{1}{4}$ in. in diameter. The cylinders are 14 in. and 24 in. in diameter and 24 in. stroke. The driving-wheel base is 12 ft. 6 in., and the total wheel-base 24 ft. 2 in. The boiler is of the straight-top pattern, 62 in. in diameter, and has 270 tubes 2 in. in diameter and 14 ft. long; the working pressure will be 180 lbs. The fire-box is 10 ft. long and 34 in. wide inside. The weight is 133,000 lbs., of which 100,000 lbs. are on the drivers. The tender is carried on eight 36-in. wheels; the tank will hold 3,600 gallons of water.

THE Detroit Dry Dock Company, Detroit, Mich., has three steel and two wooden steamers under contract. The latest contract is for a steel passenger boat 165 ft. long, 35 ft. beam and 9 ft. 6 in. deep; the engines will be triple-expansion, with cylinders 16 in., 24 in. and 38 in. in diameter and 24 in. stroke, and the boat is expected to make 18 miles an hour.

THE Ferracute Machine Company, of Bridgeton, N. J., manufacture a great variety of presses, dies, and other sheet-metal tools. They have during the past two years built a number of heavy presses which are especially adapted for railroad work. Among others are a large line of double-column presses built from both heavy and light patterns, and both with and without gearing, which can be used to advantage in cutting out various large articles, in shearing, punching, flanging and punching rows of holes in sheets, etc. There is a considerable line of work in car and railroad shops, boiler shops, etc., where such machinery can be used to much better advantage than the old-fashioned single punches. They have recently much increased their plant. They also build a special line of punching and shearing presses with a fly-wheel at the back, which are of excellent design, very massive and strong in all their parts, and which can be used not only for shearing and punching, but for cutting out various parts in thick metals. Their machinery is fitted up with forged steel shafts, hardened bolts and nuts, and with a new form of automatic clutch and graduated adjustment for slide-bars or rams, and other improvements. They have also just introduced a new line of cutting presses for lighter metals which are very handsome in design and simple in their operation. Among other large presses recently built by them is an immense cutting press for the Edison General Electric Company, which weighs 21,000 lbs. and measures 100 in. between columns, also four very large shearing and punching presses with attachments for the Pennsylvania Steel Company.

THE shops of the American Bridge & Iron Company at Roanoke, Va., include a main shop, 210×75 ft.; a templet shop, 70×20 ft; a foundry, 125×50 ft. and a machine shop, 160×50 ft., besides the engine-house, storehouse and other smaller buildings. The Company now has contracts on hand for several railroad bridges, a number of highway bridges, and for all the ironwork of a new blast furnace.

AN ingot of nickel-steel weighing 95,000 lbs., to be used in the manufacture of armor-plates, was cast in the open-hearth department of the Bethlehem Iron Works, at South Bethlehem, recently. It was 47 in. thick and 90 in. wide, and the mold in which it was cast weighed 56 tons. The ingot will be forged into armor-plate, which will be used on the battle-ship *Maine*, now being built at the Brooklyn Navy Yard.

THE Pittsburgh Bridge Company has been awarded the contract for the iron and steel work on the new Union passenger station at St. Louis. The cost for this portion of the structure alone will be nearly $350,000. The depot roof will cover a space of 424,200 square feet, said to be the largest area ever covered for railroad terminal purposes under one roof in the world.

A RECENT notice in our columns stated that the Continental Iron Works, Brooklyn, N. Y., had made a large sale of their celebrated corrugated furnaces to J. T. Ryerson & Sons, through Messrs. Fraser & Chalmers, of Chicago. This, we are later

informed, is partly incorrect. The furnaces—there were eight of them—were for Messrs. Fraser & Chalmers, of Chicago, and the order was placed through Messrs. J. T. Ryerson & Sons, who are agents of the Continental Iron Works.

THE Phœnix Bridge Company, Phœnixville, Pa., is building two iron viaducts for the Elmira, Cortland & Northern Railroad, to replace old structures. One of them is 800 ft. long and 150 ft. high at the highest point; the other is 700 ft. long and 50 ft. high.

THE Baldwin Locomotive Works, Philadelphia, recently received an order for 20 locomotives for the Lehigh Valley Railroad, in addition to 20 which are now under construction.

THE Pittsburgh Locomotive Works are building 20 locomotives for the Manhattan Elevated Railroad in New York. They are Forney engines of the standard Manhattan type.

THE Pennsylvania Railroad Company's late order for new freight cars was distributed as follows: Michigan Car Company, Detroit, 750; Peninsular Car Company, Detroit, 750; Erie Car Works, Erie, Pa., 500; Buffalo Car Company, Buffalo, N. Y., 500; Barney & Smith Manufacturing Company, Dayton, O., 500; Murray, Dougal & Company, Milton, Pa., 500; Terre Haute Manufacturing Company, Terre Haute, Ind., 500; making 4,000 cars in all.

THE N. W. Talcott Axle Works, at Brightwood (Springfield) Mass., have recently added to their business the forging of anchors. A separate building 40 × 60 ft. is set apart for this work; it has seven forges and a steam hammer, and facilities for making the largest anchors, weighing 5,000 lbs. each. About six tons per week can be turned out. There are at present only two private establishments in the country where large anchors are made—the Talcott Works and a forge at Camden, Me.—although there are anchor plants in some of the navy yards. The Talcott Works are now turning out about four tons of anchors per week, in addition to all their other work.

THE Consolidated Car Heating Company, Albany, N. Y., furnished to railroad companies 13,459 steam couplers, 459 complete car equipments, and 162 locomotive equipments during the year 1891. The car equipments included 99 to the Old Colony, 175 to the Boston & Maine, 45 to the Canadian Pacific, 64 to the Concord & Montreal, and an average of 10 a month to the Wagner Palace Car Company. On January 1 the Consolidated Company had on hand to be filled orders for 130 complete car equipments. It is announced that the Wagner Company has adopted the improved commingler (McElroy) system as well as the Sewall Coupler.

THE Baldwin Locomotive Works in Philadelphia some time ago adopted the system of subdivided power, and substituted a number of quick-acting engines for those formerly used. They have now no less than 18 Westinghouse engines in use, most of them of the compound type.

THE St. Charles Car Company, St. Charles, Mo., has under construction four passenger coaches for the Des Moines & Northwestern; four circus cars for Ringland Brothers; 10 large caboose cars for the Wabash Railroad and 100 box cars for the Pocahontas Short Line. The shops are very busy on these and other orders, including a number of freight cars for the Missouri Pacific.

AN excellent example of the use of subdivided power is found in the new Spreckels refinery in Philadelphia. There are no less than 67 steam-engines in this plant, and 61 of these are Westinghouse engines of various sizes.

THE Marinette Iron Works, West Duluth, Minn., are building triple-expansion engines for a new boat now under construction by the American Steel Barge Company. The engines will have cylinders 20 in., 32 in., and 54 in. in diameter and 42 in. stroke. The propeller will be solid, 12 ft. 6 in. in diameter and 16 ft. pitch.

THE Iowa Iron Works, at Dubuque, Ia., which is to build Torpedo boat No. 2, has decided to put in the Thornycroft boilers of the same type as those in the *Cushing*, but somewhat larger. The engines of the new boat will be required to develop about 500 H.P. more than those of the *Cushing*, as the boat is somewhat larger.

THE firm of Nassau & Kuhn, conducting the Charles C. Phillips Company in Philadelphia, has been dissolved. Mr. James Nassau has bought the plant and business of the Phillips Company, and will continue the manufacture of varnishes and japans as heretofore. Mr. Henry J. Kuhn has associated himself with the Flood & Conklin Company in Newark, N. J., in the same business.

THE American Steel Wheel Company has purchased a large tract of land at the new station known as Garwood, on the Central Railroad of New Jersey, and purposes establishing there a large manufacturing town. A considerable part of the tract will be used for their own extensive works and the rest of it will be given over to other companies. It is understood that the Hall Signal Company has already made arrangements to establish its works on a part of the tract. The property purchased includes 300 acres, and is well located for the establishment of the town.

PERSONALS.

CLEMENT F. STREET, recently Chief Draftsman of the Chicago, Milwaukee & St. Paul Railway, is now Mechanical Editor of the *Railway Review*, of Chicago.

SAMUEL A. BEARDSLEY, of Utica, has been appointed a member of the New York Railroad Commission, in place of WILLIAM E. ROGERS, whose term has expired.

E. P. LORD has been appointed Superintendent of Motive Power of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, with office at Indianapolis, Ind. He succeeds F. P. BOATMAN, resigned.

CHIEF ENGINEER GEORGE W. MELVILLE, U. S. N., has been appointed Chief of the Bureau of Steam Engineering for a second term; a well-earned tribute to his successful administration of the Bureau during the past four years.

JOHN E. SANFORD, of Taunton, has been appointed a member of the Massachusetts Railroad Commission, to succeed GEORGE G. CROCKER. He is a lawyer and has been for three years past Chairman of the Harbor and Land Commission.

THE following promotions in the United States Engineer Corps are announced: MAJOR GARRETT J. LYDECKER to be Lieutenant-Colonel; CAPTAIN JOHN C. MALLOY to be Major; FIRST LIEUTENANT GEORGE W. GOTTHALS to be Captain; SECOND LIEUTENANT HENRY GERVEY to be First Lieutenant.

MAJOR H. D. BULKLEY, a well-known expert accountant, has been appointed Comptroller of the Baltimore & Ohio Company, appointment taking effect January 1, 1892. He will have the general supervision of the accounting of the several departments, and a special supervision of the accounting of the subsidiary companies.

HENRY E. WEISGERBER, formerly General Foreman of the Baltimore & Ohio shops at Wheeling, W. Va., has been appointed General Manager of the Wheeling & Elm Grove Railroad, a narrow-gauge road running from Wheeling to Elm Grove Park, a distance of seven miles. CHARLES HIRSCH is his successor as General Foreman of the Wheeling shops.

PROFESSOR LEWIS M. HAUPT, of the University of Pennsylvania, has been appointed a member of the Ship Canal Commission of Pennsylvania, succeeding the late JOHN M. GOODWIN. Professor Haupt's reputation as an engineer is well known, and he has made a special study of canals and waterways, making his appointment a most appropriate one.

GEORGE G. CROCKER has resigned his position as a member of the Railroad Commission of Massachusetts. His term expired a year ago, but he has remained in office, the Executive Council having refused to confirm Mr. Smith, who was nominated by the Governor to succeed him. Mr. Crocker has been an excellent and capable officer, and retires with a very good reputation.

W. J. DALE, JR., of Andover, has been appointed a member of the Massachusetts Railroad Commission to succeed E. W. KINSLEY, deceased. Mr. Dale is a farmer and merchant, and recently completed a term as Assistant Postmaster of Boston; he has an excellent reputation for intelligence and energy. His appointment was made under the law which requires one member of the Commission to be a business man.

THE President has made the following appointments of members of the Interstate Commerce Commission: WILLIAM R. MORRISON, of Illinois, whose term had expired, reappointed for another term; JAMES W. MCDILL, of Iowa, to succeed JUDGE THOMAS M. COOLEY, resigned; WILLIAM M. LINDSEY, of Kentucky, to succeed the late WALTER L. BRAGG. Mr. Lindsey is a lawyer and has served as a Judge of the Court of Appeals of his State. Mr. McDill is also a lawyer; he has been

on the bench and in Congress, and served two terms on the Iowa Railroad Commission.

OBITUARY.

A. G. DARWIN, who died at Glen Ridge, N. J., January 21, aged 64 years, was largely interested in the Strong Locomotive, the Lappin Brake Shoe, and several other manufacturing companies. He was well known among railroad men.

REAR-ADMIRAL C. R. P. RODGERS, who died in Washington, January 8, aged 72 years, had served continuously in the Navy since 1833. He served through the Mexican War, and during the late war took a prominent part in the operations of the Southern coast. He served one term as Chief of the Bureau of Yards and Docks, and also one term as Superintendent of the Naval Academy at Annapolis. He was retired in 1881. In 1885 he was appointed a delegate from the United States to the International Conference held in Washington to agree on a prime meridian, and was chosen to preside over the Conference.

WILLIAM F. TURREFF died in New York, January 18, after a short illness, of pneumonia. He was 57 years old. At an early age he began work as a machinist, and after a number of years spent on various Western lines he became Division Master Mechanic on the Cleveland, Columbus, Cincinnati & Indianapolis Railroad, and later Superintendent of Motive Power of the whole road. A few months ago he resigned that position to accept the office of Assistant Superintendent of Motive Power of the New York, Lake Erie & Western. Mr. Turreff was highly esteemed both personally and as a capable officer; he was widely known and had many friends.

ROSWELL B. MASON, who died in Chicago, January 2, aged 86 years, was born in New York, and commenced work as an assistant in one of the engineer corps on the Erie Canal. He was for several years connected with the Morris Canal, in New Jersey, and afterward was employed on the Housatonic, the New York & New Haven and the Vermont Valley Railroads. In 1851 he went to Illinois as Chief Engineer on the Illinois Central, and after the completion of that road was employed on some other railroad lines and on the Illinois & Michigan Canal. He was Mayor of Chicago at the time of the great fire, and the work done by him in that emergency is still remembered. He retired from business some years ago.

GENERAL MONTGOMERY C. MEIGS, who died in Washington, January 2 aged 75 years, was born in Augusta, Ga., and graduated from West Point in 1836. He was at first attached to an artillery regiment, but in 1837 was transferred to the Engineer Corps, in which he served 24 years. He was employed in the construction of several of the old forts on the seaboard and the lakes, and in 1852 was assigned to duty on the Washington Aqueduct, the survey and location of which was largely his work. He won a high reputation from his designs, which included the famous Rock Creek and Cabin John bridges. He was also for a time in charge of the extension of the Capitol, including the building of the great dome. When the war began, in 1861, he was appointed Quartermaster-General, and served in that capacity until 1878, when he was placed on the retired list, having reached the limit of age prescribed by law. His services in organizing the department and meeting the requirements made upon it, especially in the early part of the War, when the Army was increasing at an extraordinary rate, entitled him to a high place in the history of the period. After the War he visited Europe twice, in 1867 on a furlough for his health, and in 1875–76 on a special mission to study European army organizations. In 1876 he served on the commission appointed to report on the reorganization of the Army. Since his retirement he has had charge of the building of the Pension Office in Washington. General Meigs had a high reputation as an engineer and as a student of military science; he was a Regent of the Smithsonian Institution and a member of the National Academy of Sciences and of other scientific bodies.

EDWARD NICHOLS, President of the Brooks Locomotive Works, died in Dunkirk, N. Y., January 6, aged 41 years. The cause of his death was pneumonia, which resulted from exposure during the fire at the Locomotive Works on the night of January 31. Mr. Nichols was born in Middlebury, Vt., and graduated from the Rensselaer Polytechnic Institute, at Troy, in 1871. For a short time he was instructor in chemistry in the Institute, and afterward traveled for some time in Europe, studying and perfecting his knowledge of mining and metallurgical engineering. He was a member of the Reception Committee of the American Institute of Mining Engineers during the Centennial, in 1876, and was afterward for some time in the Bethlehem Iron Works and in the iron works at Lewistown, Pa. About 1879 he became associated with some gentlemen from Troy and Philadelphia in establishing a blast furnace in Northern Georgia. He was in charge of this for several years and also for a time served as State Geologist of Georgia. In 1883 he removed to Columbus, O., and was shortly afterward married to Miss Jessie Brooks, daughter of the late H. G. Brooks. His wife, however, died two years later, leaving her husband a young son.

In 1885 Mr. Nichols became Vice-President of the Warren-Scharf Asphalt Paving Company of New York, but two years later he gave up this position and was elected President of the Brooks Locomotive Works on the death of Mr. H. G. Brooks. Since then he has been at the head of the Works, and has shown himself conspicuously fitted for the position. He was highly esteemed by his friends and neighbors, and at their repeated solicitation served as Councilman from the Second Ward of Dunkirk, and took a prominent part in securing some important improvements in the city. He was also at the head of the Young Men's Building Association, and took a prominent part in many efforts for the public welfare.

Mr. Nichols' death will be deeply regretted by all who knew him, as well as his immediate associates, and his early death has cut short a life which promised to be one of the highest usefulness.

PROCEEDINGS OF SOCIETIES.

American Society of Naval Engineers.—The annual meeting was held at the Navy Department in Washington, December 22. The Secretary's report showed nearly 400 members.

Papers were read on Drainage for Ships, by Passed Assistant Engineer Worthington, and on Electric Light Appliances, by Passed Assistant Engineer G. W. Baird.

The following officers were elected for the ensuing year: President, Chief Engineer David Smith; Secretary and Treasurer, Passed Assistant Engineer Walter McFarland; Members of Council, Passed Assistant Engineers H. Webster, F. H. Bailey and W. F. Worthington.

New England Railroad Club.—At the regular meeting, in Boston, December 9, the subject for discussion was Tools for Railroad Shops; it was opened by Mr. E. E. Davis, who spoke of the advantages of special tools, and the waste and loss caused by keeping in use old tools, when better types had been devised for doing the same work. Other speakers generally agreed with these views.

American Society of Civil Engineers.—At the regular meeting of December 16 the Secretary announced the deaths of two members, John Lockwood and Colonel William E. Merrill.

A paper on the Red Rock Cantilever Bridge, by S. M. Rowe, S. W. Robinson and H. H. Quimby was read and briefly discussed.

AT the regular meeting in New York, January 6, there was a discussion on Mr. Waddell's paper on Disputed Points in Bridge Designing. Papers were read by Mr. R. B. Stanton on the Cañons of the Colorado River, and by Major A. F. Sears on Railroads in Peru. The discussion was on the availability of the cañons for railroad location.

The following elections were announced:

Members: James W. Deen, Salida, Col.; William M. Gordon, Albemarle, N. C.; Herbert F. Northrup, Traverse City, Mich.

Associate Members: Charles A. Cockroft, Syracuse, N. Y.; William H. Converse, Chattanooga, Tenn.; Alexander Potter, Rome, N. Y.; F. Rosenberg, Pueblo, Col.; Albert Smith, Washington, Pa.; Howard J. Cole, New York.

THE programme for the annual meeting stated that the meeting was to begin at 10 o'clock on Wednesday, January 20, at which session the annual reports were made, officers elected, reports of committees presented and discussed, time and place for the next Convention considered, general business transacted.

Lunch was served at the Society House at 13.30 o'clock, and the session resumed in the afternoon.

On the evening of Wednesday the meeting was continued. During the evening the Elevated Railroad in St. Louis was described by Mr. Robert Moore, and a description of the New Passenger Elevators and Iron Viaduct of the North Hudson

Company Railway, at Weehawken, N. J., was given by Messrs. George H. Blakeley and Mr. Thomas E. Brown, Jr. These descriptions were illustrated by the stereopticon.

On Thursday, January 21, there was an excursion. The points visited were: The New Passenger Elevators and Iron Viaduct of the North Hudson Company Railroad, by invitation of Mr. Charles B. Brush, Chief Engineer; Mr. Thomas E. Brown, Jr., Consulting Engineer, and Mr. George H. Blakeley, Engineer for the Contractors. To those who so desired time was given to visit the Reservoir and High Service Tower of the Hackensack Water-Works, also by invitation of Mr. Brush.

The party then proceeded by special steamer (lunch being served during this trip) to the Brooklyn Navy Yard where, by the courtesy of Captain Henry Erben, U. S. N., Commandant Navy Yard and Station, the following interesting work was inspected: The armored cruisers *Maine* and *Cincinnati*, now under construction; the new double-turreted armored ship *Miantonomah*; the machine and boiler shops, in which were found two pairs of marine engines building for the cruisers *Cincinnati* and *Raleigh*, and the Ordnance Shops.

In the evening a reception for gentlemen was held at the House of the Society, and at 21.30 o'clock supper was served.

The officers elected are: President, Mendes Cohen, Baltimore; Vice-Presidents (two years), Samuel Whinery, Charles B. Brush; (one year), Samuel M. Gray, John McLeod; Secretary, Francis Collingwood; Treasurer, John Bogart.

Iowa Civil Engineers and Surveyors' Society.—The annual meeting began in Burlington, Ia., December 29, with a good attendance. Correspondence from absent members and suggestions for work and legislative rules were read by the Secretary, Mr. Seth Dean, and President Tschirgi being unavoidably absent, his address was read by the Secretary.

Professor L. Higgins read a paper on needed changes in the laws relating to County Surveyors. Papers on Permanent Reference Marks, by C. W. Bisbee, and on Clay for Brick Making, by W. Steyh, were read and discussed.

On the second day the Report of the Executive Committee was read and approved. A very interesting paper was next read by G. Davis, C.E., on Iron. The paper was lengthy and explained quite fully the methods of manufacturing this metal for the different purposes for which it is used.

The Report of the Committee on Practical Work was an answer to the several questions that had been referred to them.

J. M. Brown, C.E., next read a paper on the cost of earthwork, giving an analysis of the elements entering into the problem under the different methods of handling, by both drag and wheel scrapers; also by wagons and by cars, with steam shovel for loading.

Papers were next read by the Secretary, as follows: Tide Lands of the Columbia River, by A. B. Little, C.E.; Trials of a County Surveyor, by D. O. Potter; Title by Adverse Possession, by Seth Dean; Calculating Overhaul, by R. G. Brown. Mr. Brown also furnished a supplemental article to his paper published last year on the Measurement of Earthwork; also an explanation of the principles of the "Kite" race track. Edward M. Gilchrist, C.E., furnished a paper on the subject of Relative Economy of Wood *vs.* Iron for Truss Bridges in Iowa. A discussion followed the reading of each of these papers which was quite generally participated in by the members present.

Amendments to the constitution were proposed changing the time of annual meeting to the third Wednesday in January; also that the Executive Committee take the necessary steps to have the Society legally incorporated.

The following named parties were elected for officers for the next year: President, William Steyh, C.E., Burlington; Vice-President, J. H. Cole, Keokuk; Secretary and Treasurer, Seth Dean, Glenwood; Directors, F. A. Macdonald and J. D. Wardle, Cedar Rapids.

The following named parties were appointed on the various committees:

Committee on Legislation, Professor L. Higgins; M. R. Laird, Des Moines; Edward M. Gilchrist, Keokuk.

Committee on Practical Work, J. S. Ratcliff, Waukon; W. L. Breckenridge, Burlington; J. M. Brown, Cedar Rapids.

A memorial to the Iowa members of Congress, asking in substance for their support of a measure transferring the work of internal improvements from the Secretary of War to the Secretary of Agriculture was passed.

The question of selecting the place for the next annual meeting was, on motion, left to be determined by a letter ballot.

After passing a vote of thanks to the city officers and the members of the Commercial Club and the citizens of Burlington for favors shown them, the Convention adjourned, thus closing the best and most interesting session the Society has ever held.

After adjournment an excursion to various places of interest was enjoyed by many of the members.

Michigan Engineering Society.—The thirteenth annual convention was to be held in Grand Rapids, January 19, 20 and 21. The programme included papers by members as follows: George S. Pierson, A Method of Sewage Disposal; J. H. Forster, Hydrographic Surveying; A. L. Reed, Development of Water-Bearing Strata, for Irrigation; S. E. Jarvis, Pneumatic Street Railway Propulsion; Professor W. H. Pettee, Building Stones of Michigan; A Recent Decision of the Supreme Court of the United States on the Ownership of Lake Beds; E. H. Mumford, Notes in a Rolling Mill; E. W. Muenscher, Easement Curves, and numerous others. A large attendance was expected, and careful arrangements had been made for the meeting.

American Forestry Association.—At the annual meeting which was held in Washington, December 29 and 30, the Secretary's report showed progress in the work. The chief effort of the year has been to secure the reservation of portions of the public timber lands under the act passed by the last Congress, and the Association has succeeded in having several reservations already made, and examination is now being made of other tracts.

The report of the Executive Committee, which was read by Professor B. E. Fernow, called attention to the growing needs for forest reservations, and stated that the necessity of preserving as well as setting aside those reservations has been recognized. A bill has been prepared to be submitted to Congress providing for the division in the general land office with a competent chief and assistants and a force of superintendents and forest rangers to prevent encroachments.

The Association approved these reports, and adopted a memorial to the President and Congress in favor of carrying out the recommendations.

The following officers were elected for the ensuing year: President, William Alvord, San Francisco; Recording Secretary, Dr. N. H. Eggleston, Washington; Corresponding Secretary, Edward A. Bowers, Washington; Treasurer, Dr. Henry N. Fisher, Philadelphia; Executive Committee, Professor B. E. Fernow, General J. Grant Wilson, Colonel E. T. Ensign, H. B. Ayres, Warren Higby and Henry Pellew.

Boston Society of Civil Engineers.—At the regular meeting in Boston, January 18, the subject for discussion was Government in Large Cities. It was opened by President F. P. Stearns by a brief address, and papers were then read on the Methods of Municipal Government in various cities as follows: Philadelphia, Professor Dwight Porter; St. Louis, Mr. Robert Moore; Boston, City Engineer William Jackson; New York, Francis M. Scott; Providence, City Engineer J. H. Shedd; Buffalo, E. B. Guthrie. The list was concluded by a paper on the Municipal Government of Paris by Mr. H. D. Woods.

New England Water-Works Association.—The Association held a regular meeting at Young's Hotel, Boston, on January 13, with about 75 members and visitors present. The usual dinner was followed by a business meeting at 2.30 o'clock, with President H. G. Holden in the chair and W. H. Richards Acting-Secretary. A letter was read from W. M. Hawes, Water Commissioner of Fall River, Mass., conveying his thanks and expressing his appreciation of the Christmas remembrance sent him by the Association as a token of esteem.

The President then introduced Reuben Shirreffs, Second-Assistant Engineer of the East Jersey Water Company, who read a paper describing the works of the East Jersey Water Company for supplying the city of Newark, N. J. This paper was illustrated with lantern views, showing the different features of the dams, riveted pipe line, etc., and was afterward informally discussed by Desmond FitzGerald, H. G. Holden, and others.

The following members were elected: *Resident, active*: Frederic I. Winslow, Boston; G. O. Sanders, Hudson, N. H.; John F. Springfield, Rochester, N. H.

Associate: George K. Paul, Boston.

Engineers' Club of Cincinnati.—The fourth annual meeting was held December 18. Messrs. Charles E. Lindsay, H. H. Hankens, Charles F. Koch and James A. Stewart were elected members.

Resolutions on the death of Colonel W. E. Merrill, who was one of the founders of the Club and its first President, were adopted. The Secretary presented his report showing 105 members, an increase of 9 during the year. The Treasurer's report was also submitted.

The following officers were elected for 1892: President, Samuel Whinery; Vice-President, Latham Anderson; Secretary and Treasurer, J. F. Wilson; Directors, W. B. Ruggles, H. J. Stanley, E. A. Hill.

The retiring President read a very interesting report giving a general résumé of Engineering progress in 1891.

Engineers' Club of Philadelphia.—At the annual meeting in Philadelphia, January 16, Mr. Wilfred Lewis, the President, delivered his annual address, referring to the growth and prosperity of the Club during the past year.

It was reported that the total number of members was 421. There had been a large increase in attendance at meetings and in the number of papers presented for reading.

The officers chosen for the following year were: President, James Christie; Vice-Presidents, Frederick H. Lewis and Pedro G. Salom; Secretary, John C. Trautwine, Jr.; Treasurer, T. Carpenter Smith; Directors, John E. Codman, George V. Cresson, Strickland L. Kneass, Wilfred Lewis, H. W. Spangler, David Townsend.

Engineering Association of the South.—The regular meeting, December 12, was held in the new rooms in Nashville, Tenn., for the first time. Several applications for membership were received. The Secretary presented the specifications governing the competition for the cash prize of $1 000 offered by the Board of Public Works of Duluth, Minn., for the best plans for a draw-bridge across the ship canal at that place.

Professor Olin H. Landreth brought up for consideration the question of instituting, under the auspices of the Association, a competitive trial of machinery used in highway building—such as graders, ditchers, surfacers, rock-crushers, steam and horse rollers, etc. After an extended discussion by Messrs. E. C. Lewis, Hunter McDonald and W. H. Lyle, which in the main was favorable to the enterprise, a committee was appointed by the Chair to investigate and report at the next regular meeting the feasibility of instituting the competitive trial proposed. Messrs. Olin H. Landreth, W. G. Kirkpatrick and J. A. Fairleigh comprised the committee.

Montana Society of Civil Engineers.—The annual meeting was held in Helena, Mont., January 9. The retiring President, Mr. E. H. Wilson, delivered his annual address. Reports were presented on Improvements to the Public Surveys and on the Engineering Congress at the Columbian Exposition.

The reports of the Secretary and Treasurer were read, and showed that the Society is financially in a prosperous condition. The election of officers resulted as follows: President, Colonel Walter W. De Dacey, of Helena; First Vice-President, Albert B. Knight, of Butte; Second Vice-President, J. S. Keerl, of Helena; Secretary and Librarian, F. D. Jones, of Helena; Treasurer, A. S. Hovey, of Helena; Trustee, Elliott H. Wilson, of Butte.

The meeting was concluded by a banquet in the evening.

Engineers' Club of St. Louis.—At the annual meeting, December 2, the reports showed a total of 136 resident and 45 non-resident members and 1 honorary member. There were 19 meetings held last year, at which 20 papers were read; a number of papers are already promised for 1892. The expenses were $1,554.

The officers for 1892 are: President, I. B. Johnson; Vice-President, B. L. Crosby; Secretary, Arthur Thatcher; Treasurer, C. W. Melcher; Librarian, R. E. McMath; Directors, George Burnett and B. H. Colby.

Civil Engineers' Society of St. Paul.—The annual meeting was held in St. Paul, January 4. Mr. Alfred Jackson was elected a member.

The following officers were elected for 1892: President, E. E. Woodman; Vice-President, J. D. Estabrook; Secretary, C. L. Annan; Treasurer, A. O. Powell; Librarian, A. Münster; Representative in Board of Managers of Association of Engineering Societies, C. J. A. Morris.

Western Society of Engineers.—The twenty-third annual meeting was held January 6, in the Sherman House, Chicago. Of the 206 votes cast for President—partly by letter—Isham Randolph received 100; J. F. Wallace, 84, and L. P. Morehouse, 22. President L. E. Cooley decided that Mr. Randolph had received a majority of the votes properly cast, but this decision was overruled on an appeal. Accordingly, the President will be chosen at the February meeting, Mr. Cooley holding over until then. The officers chosen were: First Vice-President, E. C. Carter, Chicago; Second Vice-President, Professor Ira O. Baker, Champaign, Ill.; Secretary and Treasurer, John W. Weston (re-elected); one Trustee, Charles L. Stroble. The membership is now 405, an increase of 67 during the year. After the election a dinner was served and speech-making was indulged in.

New York Railroad Club.—At the regular meeting, December 17, 15 new members were elected.

A paper was read by Mr. W. G. Berg, Principal Assistant Engineer, Lehigh Valley Railroad, on Coaling Stations for Locomotives. Mr. Berg was followed by Mr. H. A. Ainsworth, who described the Clifton chute. There was a brief discussion, during which a letter from Mr. A. J. Swift, Chief Engineer, Delaware & Hudson Canal, was read, speaking very highly of the Clifton chute in service on that road.

Mr. Ennis, Master Mechanic, New York, Susquehanna & Western, brought up the question as to whether or not there should be a labor charge made for putting on a brake-shoe or putting in a brass on a foreign car. The following resolution was adopted: That there should be no labor charge made for putting on a brake-shoe or putting in a brass in a foreign car, and that a modification to this effect should be made in Rule 8 of the interchange rules. It was also voted that other railroad clubs should be notified of this action of the New York Railroad Club

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Texas Railroad Club.—This Club was organized at Fort Worth, Tex., November 16, when the following officers were chosen: President, John F. White; Vice-President, A. S. Douglas; Treasurer, Robert E. Masters; Secretary, Thomas A. Kuntz; Directors, W. P. Siddons, William O'Herin, Thomas Inglis, J. J. Ryan and James McGee. The Secretary's address is at Fort Worth, Tex.

American Society of Mechanical Engineers.—The Secretary has issued a pamphlet giving a full account of the meeting to be held in San Francisco in May next, and of the excursions proposed in connection with that meeting. From this members who desire to attend can ascertain the expense of the trip, how much ground they will be able to cover, with many other interesting points.

NOTES AND NEWS.

Aluminium.—Professor J. W. Langley has prepared an alloy of aluminium and titanium, which is as hard as the hardest steel, but has a specific very little above that of pure aluminium. The proportion of titanium in the alloy is somewhat less than 10 per cent.; a larger proportion was found to make the metal too brittle. The Pittsburgh Reduction Company is now making this alloy.

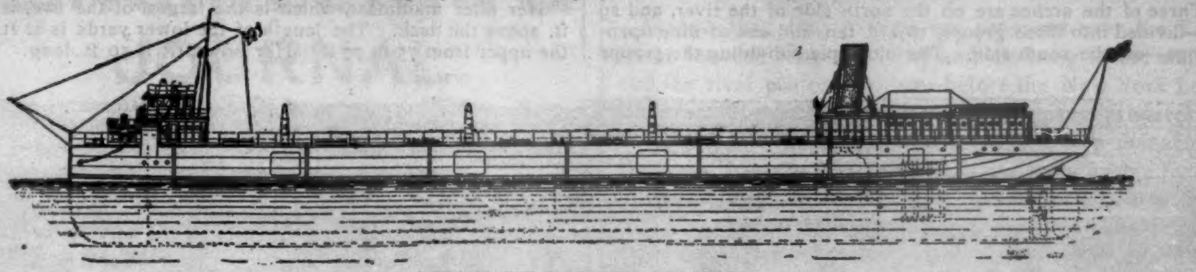
A life-boat of aluminium has been made at Stralsund, Germany, and some experiments with it will be made by the German Navy. Its lightness is a great advantage, if its other qualities prove good.

Steam Pipes.—Exposed pipes are great consumers of heat. Some time ago it was calculated that a foot of 2-in. pipe carrying 60-lbs. steam pressure left uncovered cost a dollar a year, and the figure is not far out of the way. It is better economy to get a good covering for steam pipes than to burn coal to make up the loss in heat.

Ventilation of Railroad Tunnels.—An ingenious method of extracting the foul air and products of combustion from underground railroads—or, rather, of preventing their entry into the tunnels—has been devised by Mr. Chris Anderson, of Leeds, and tried recently on a portion of the Metropolitan Railroad. The object in view is effected by making a connection between the smoke-box of the moving locomotive and a stationary flue connected with exhausting apparatus. To this end a rectangular tube, having at intervals valves opening downward on its top side, is fixed between the rails. One end of this tube as now laid is closed, while the other end, half a mile away, is connected with a Root's blower driven by a small engine. The locomotive, which is one of the company's ordinary passenger engines, is fitted with a long sliding box, which is open on the underside and is carried beneath the engine. This slider is connected at its front end by a down chimney with the smoke-box of the engine. There is a valve in this chimney, and another in the ordinary funnel of the engine, both being worked by a hand lever, and being so arranged that on opening one the driver closes the other. Thus, when the train is in the tunnel the products of combustion can be directed into the tube, and when in the open they can be allowed to pass through the funnel into the air. The slider glides freely on the top of the rectangular tube, and it has a rib running centrally its whole length, which, as it passes over each valve, presses down a projection on it and opens it. The distances between the valves and the length of the central rib of the slider are so relatively proportioned that a valve is always open to admit the products of combustion to the tube.—*Practical Engineer, London.*

An African Tunnel.—The Laing's Nek Tunnel, on the extension of the Natal Railroad, in South Africa, has lately been completed. It is 2,300 ft. long, and was cut chiefly through a hard blue shale, with occasional veins of harder rock.

New Lake Freight Steamers.—It is announced that the Anchor Line has let contracts for three new freight steamers, which will carry 2,700 tons each on 15½ ft. draft. They will cost about $178,000 each, and will be built respectively by the Union Dry Dock Company at Buffalo, the Globe Iron Works at Cleveland and the Detroit Dry Dock Company at Detroit.

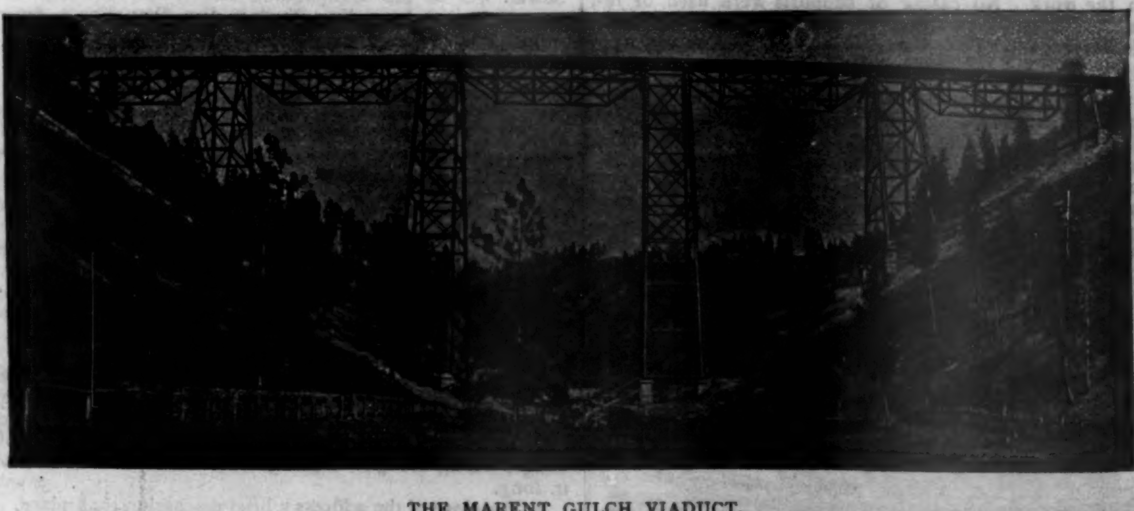


A NEW LAKE FREIGHT STEAMER.

The general plan is shown in the accompanying sketch, from the *Marine Review*.

A new feature in the boats, which are to be duplicates in all respects, with the exception of probably a slight difference in the proportion of engines, is the absence of sheer in their construction. They will be built without any sheer—that is, they will be the same depth at ends as in the middle, and the gunwale will be a bevel line. In this there is said to be a saving of $12,000 to $15,000 on boats of this class. The boats are to be 275 ft. keel, 40 ft. beam and 26 ft. depth from base line to top of spar deck beams at side. The boats to be built by the Globe Company, of Cleveland, and the Detroit Dry Dock Company, will be engined by those companies; but H. G. Trout & Company, of Buffalo, will build the engines for the steamer to be built by the Union Dry Dock Company, and the Lake Erie Boiler Works, also of Buffalo, will build the boilers. The engines to be built by Trout will be 20, 33 and 54 in. × 45 in. stroke. The two boilers will be 12 ft. long and 14 ft. diameter, to be allowed 160 lbs. of steam. The boats will have steam capstans, windlasses, steerers and line shafting for hoisting purposes, together with electric lighting plants and all modern arrangements for rapid work in port.

The Marent Gulch Viaduct.—An interesting paper, recently read before the American Society of Civil Engineers by Mr. George S. Morison, describes this viaduct, which was designed by him, and which was built to replace a wooden structure. The change was made because it was not considered safe in the dry climate of Montana to retain so important a bridge in wood, where it was liable at any time to be destroyed by fire and to interrupt seriously the traffic of the road.



THE MARENT GULCH VIADUCT.

The general plan is shown in the accompanying illustration. The viaduct consists of five spans, each 116 ft. 8 in. long, two towers, each measuring 23 ft. 4 in. on top, and four girder spans of 30 ft. each, making the total length of the structure 796 ft. 8 in. The total height from the top of the masonry to the top of the stringer at the highest side of the central tower is 201 ft. 9 in. The viaduct is straight, but is built on a grade of 1.96 per cent.

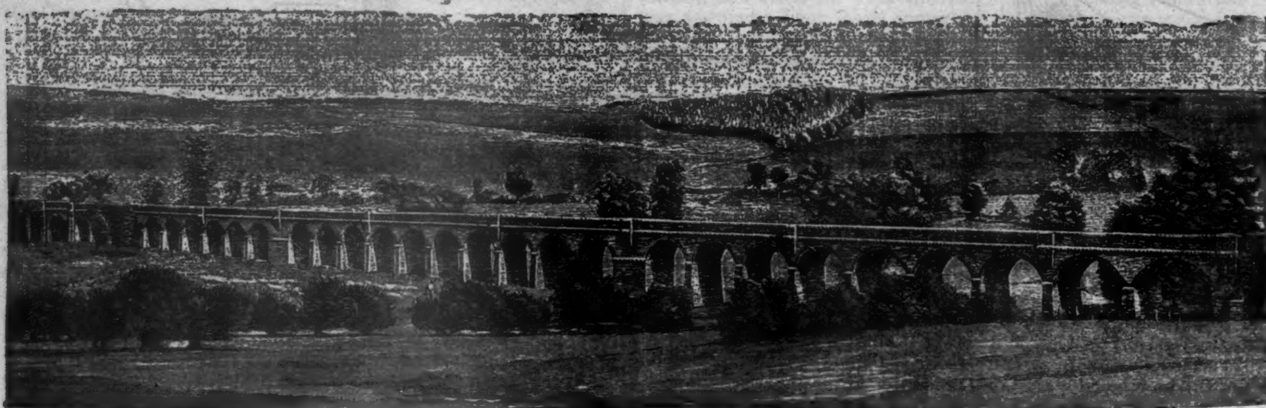
The substructure consists of two small abutments and 24 small piers. They are generally founded upon rock, but in two instances were founded on clay and gravel, the area of the foundations being increased, and in two other cases piles were driven through clay until hard material was reached.

The towers were made of the same length on the top as the panel in the spans between them, in order to make the floor system uniform; in the direction of the bridge the batter was 1 in 48, while the side batter was 1 in 6, which made the high towers 31 ft. 3 in. × 83 ft. 2 in. at the base. The spans are deck truss, pin connected. There is a complete iron floor, the floor-beams resting on top of the chords and the stringers on top of the floor-beams. The wooden floor is laid on the stringers. The total weight of material in the structure was 1,673,039 lbs., of which 868,351 lbs. were in the towers, the balance in the substructure and flooring. The iron work was furnished by the Union Bridge Company, with the exception of a number of eye-bars, which were made by the Passaic Rolling Mill Company. The total cost of the bridge was $153,362.

A Japanese Mountain Railroad.—A new mountain railroad, to connect Karuisawa with Yokohama, is under construction over the Usui Mountain in Japan. The road is 7.3 miles long, and has 21 tunnels, the total length of which is 12,200 ft. The heaviest grades are 352 ft. to the mile, and the line will be worked on the Abt rack-rail system.

A Swedish Railway Project One Hundred Years Ago.—Close upon 40 years before Stephenson's victory, a Swedish engineer, Karl Hogstrom by name, not only constructed a locomotive on similar lines to the one of Trevithick and Vivian, but also conceived a plan of a regular railroad. His first notion was that his locomotive should be used on ordinary roads, but soon realizing the insurmountable difficulties attending this style of locomotion, he, in the year 1791, brought out his railroad scheme. The rails were to be of cast iron and perfectly smooth, and in order to prevent derailment the wheels were to have a projecting edge. Convinced of the insufficiency of friction between the smooth wheels and rails for the propelling of heavy trains, Hogstrom proposed that a toothed wheel on his locomotive should work on a central toothed bar or rail placed between the other rails—a plan which of late has been adopted in several instances where the gradient has been exceptional. Hogstrom's plan was laid before several scientists, who were unanimous in denouncing it as utter madness, as it was absurd to imagine that a carriage could ever be propelled by steam alone. The plan was entirely shelved, and nothing more appears to be known as to the fate of Hogstrom, who afterward went abroad.—*London Engineering.*

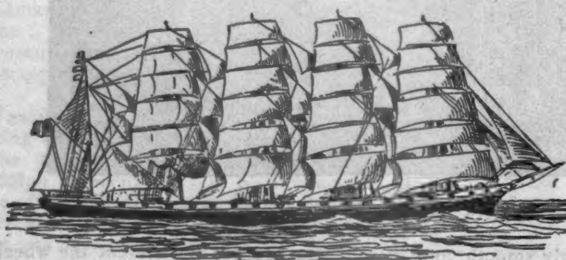
The Twyford Viaduct.—The accompanying illustration, from the London *Engineer*, shows a viaduct recently built to carry the Didcot, Newbury & Southampton Railroad over the valley of the Itchen River, near Twyford, England. The viaduct has 34 arches, 33 of them being 30 ft. span with a rise of 10 ft., and one, across the Itchen, 50 ft. span and 14 ft. rise. Three of the arches are on the north side of the river, and 29—divided into three groups, two of ten and one of nine openings—on the south side. The block piers dividing the groups are 26 ft., the river piers 12 ft. and the others 9 ft. each. The foundations rest partly in gravel and partly in the chalk, solid bottom being reached at a depth of from 8 ft. to 16 ft.



THE TWYFORD VIADUCT.

The arches and parapets are of solid brickwork; the piers and the rest of the masonry are of concrete faced with brick. The concrete was formed of clean washed gravel and sand in the proportion of five of gravel and one of sand to one of Portland cement. In building, after the concrete foundation had become set, a course of brick headers was laid round the pier on the face line, and on the top of this four other courses of stretchers, 15 in. total height. After an interval of one day, into the space behind this skin was placed the cement concrete, and brought up to a level. This was then allowed to rest another day, and then a similar operation of five courses of brickwork with concrete backing was repeated, and so on until complete; at a height of every 3 ft. two courses of bricks were carried through the work. No casing or supports were used or required to the brick face, great care being taken in levelling in the concrete behind, and a perfect face was maintained throughout.

The Largest Sailing Ship.—The largest sailing ship in the world, the *France*, was built last year by David & William Henderson, Meadowside, Partick, Scotland. She is of steel and will form an important acquisition to the mercantile fleet of France, in which country she is owned. Her dimensions are 360 ft. long by 48 ft. 9 in. broad and 30 ft. deep. Her gross tonnage is about 3,750 tons, with a dead-weight carrying capacity of 6,150 tons. In these and all other particulars she is much larger than any other sailing vessel afloat; her sails, which were made in France, present an area of no less than 46,000 sq. ft. She is rigged as a five-masted bark, and in order to cope with the immense size of her sails and spars, her rigging is of the most complete description, fitted with all the most modern and improved appliances for their easy handling. The vessel will be principally engaged in the nitrate trade. In order to preserve the nitrate solution, which is formed in large quantities, and which is usually discharged overboard, tanks are fitted in the hold, thus insuring the shippers against loss resulting from this waste. The poop is fitted with a handsome saloon, containing accommodation for captain, officers and a limited number of passengers. The crew are berthed in a large deckhouse abaft the foremast, and the petty officers' and apprentices' berths and messroom are in the deckhouse aft of same. In the forecastle a large, airy room is set apart as a hospital.



SAILING SHIP "LA FRANCE."

Her after mainmast, which is the largest of the five, is 167 ft. above the deck. The length of the lower yards is 82 ft., of the upper from 75 to 77 ft. Her bowsprit is 50 ft. long. The fifth mast was said by the captain to assist the working of the ship greatly, as she tacked very easily. On her first voyage, which was from Cardiff to Rio Janeiro, she reached a speed of 12½ knots an hour. She was then laden with 6,000 tons of coal. The *France* arrived in San Francisco last month from Newcastle with a full cargo of soft coal.

Other large sailing ships are the *Liverpool*, 333 ft. long; the *Palgrave*, 3,078 tons register. Within two years Arthur Sewell & Company, Bath, Me., have built and launched three large wooden ships, the *Shenandoah*, 3,407 tons gross and 3,258 net; *Rappahannock*, 3,185 gross and 3,054 net; and the *Susquehanna*, 2,740 gross and 2,629 net. The *Susquehanna*, just completed, and which has been the only wooden ship on the stocks in the United States the past summer, represents something like $140,000, will carry with ease 4,000 tons of freight, and will be ready for sea this month. Captain Joseph E. Sewall will be the commanding officer, and will take her, as soon as loaded, from New York to San Francisco.—*American Shipbuilder.*

The Chignecto Ship Railroad.—It is stated that Mr. Ketchum, the Engineer of the Chignecto Ship Railroad, is now in London, and will make an attempt to secure Government aid for the completion of this work. About $3,500,000 have been expended on the railroad, and $1,500,000 more are needed for its completion.

Flying Machines.—Mr. Maxim, the inventor of the Maxim gun, speaking at a meeting of the English Aeronautical Society recently, explained the progress he had made with his experiment to produce a machine by which it will be possible to introduce aerial navigation. He has already spent £10,000 on these experiments, and has arrived at such important results that he regards it as certain that in the near future he will achieve success.

Mr. E. F. Frost, of West Wratting Park, Cambridgeshire, gave a detailed description of a flying machine, the construction of which he has been engaged on for many years, after much study of birds. He produced one of the feathers of one of his wings, which, though weighing only a few ounces, is 10 or 12 ft. long.

At the close of the address a brief discussion took place. Sir James Douglas described some of the results stated by Mr. Maxim as most astounding, and as showing the practicability of aerial navigation.

A Mississippi Steamer.—One of the latest types of Mississippi River steamboats is the *T. P. Leathers*, just completed for the trade between New Orleans and Vicksburg. The *Leathers* is a stern-wheeler, and is 226 ft. long, 40 ft. beam and 6 ft. 6 in. depth of hold. The wheel is 26 ft. in diameter and 21 ft. face, and is driven by two horizontal engines having cylinders 20 in. in diameter and 7 ft. stroke. There are three boilers 42 in. in diameter and 34 ft. long, each having two flues. The cabin is on the upper deck and has accommodations for a number of passengers.